Appendix H: Rye Park wind farm Preliminary Documentation – Prescribed Impacts Assessment

APPENDIX E

Rye Park Wind Farm – Prescribed Impacts Assessment

Environmental & Social Consultants

RYE PARK WIND FARM

BDAR – Prescribed Impacts
Section 9.2.1.8

FINAL

August 2020

RYE PARK WIND FARM

BDAR – Prescribed Impacts
Section 9.2.1.8

FINAL

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1.0 Introduction

This document has been prepared to address criterion 9.2.1.8 a- k within the ‘assessing prescribed biodiversity impacts’ section of the Biodiversity Assessment Method as required under the NSW *Biodiversity Conservation Act 2016* (BC Act) for the proposed Rye Park Wind Farm modification. These criterion request further analysis of project related impacts on aerial species, particularly threatened species. Aerial species considered as part of this analysis were selected based on recorded flight data collected during bird and bat utilisation surveys during 2011-2013 (NGH 2014) and during 2018/19 by Umwelt in the Project Area. At the request of the Biodiversity and Conservation Division 14 species were considered in this assessment comprising 13 threatened species (nine bird and four bat species) and one non-threatened bird species (wedge-tailed eagle).

This assessment considers the utilisation of the 14 fauna species across a broad Project Area, which includes the extent of landholdings involved with the Project. This is necessary to capture given the mobility of the species being assessment and the criterion being considered.

In **Figures 4.1**, **4.2** and **4.3**, we present the Indicative Development Footprints which comprises the entirety of the Indicative Development Footprint for the Rye Park Wind Farm. The Indicative Development Footprints includes a combination of the Indicative Development Footprint – Wind Farm, the Indicative Development Footprint – External Roads and the Indicative Development Footprint – Permanent Met Masts.

2.0 Predict the likelihood of impact on aerial species resident in, or likely to fly over, the project area including but not limited to bat/bird strike and barotrauma

To ascertain the likelihood and consequence of impacts on aerial species, a risk-based assessment approach has been applied. This assessment has been developed based on a recent report completed by the Arthur Riley Institute (Lumsden *et al.* 2019). The assessment considers the likelihood of blade strike based on recorded flight behaviours and assesses consequence using a range of measures associated with population ecology, abundance and conservation status.

The results of the risk assessment are summarised in **Table 2.1** below, with five species considered a high risk, six considered a moderate risk and three considered a minor risk of being impacted by the Project. The resultant risk rating for these species is primarily due to their relative abundance in the Project Area, their predicted or observed flight behaviour in the Project Area and/or their known susceptibility to blade strike at wind farms in south-east Australia.

The interpretation and justification for these results is provided in **Section 4.0** with reference to data collected during bird utilisation surveys conducted in the Project Area and in consideration of the scant relevant and publicly available data from Australian wind farms.

Table 2.1 Risk Assessment Summary

Common Name	Latin Name	Likelihood	Consequence	Risk Rating
Little eagle	*Hieraaetus morphnoides*	High	Moderate	High
Black falcon	*Falco subniger*	High	Moderate	High
Wedge-tailed eagle	*Aquila audax*	High	Low	Moderate
Superb parrot	*Polytelis swainsonii*	High	Moderate	High
White-throated needletail	*Hirundapus caudacutus*	High	Moderate	High
White-fronted chat	*Epthianura albifrons*	High	Low	Moderate
Brown treecreeper	*Climacteris picumnus victoriae*	Low	Moderate	Minor
Varied sittella	*Daphoenositta chrysoptera*	Moderate	Low	Minor
Painted honeyeater	*Grantiella picta*	Moderate	Moderate	Moderate
Dusky woodswallow	*Artamus cyanopterus*	High	Low	Moderate
Large bent-winged bat	*Miniopterus schreibersii oceanensis*	High	Moderate	High
Yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	Moderate	Moderate	Moderate
Southern myotis	*Myotis macropus*	Low	Moderate	Minor
Eastern false pipistrelle	*Falsistrellus tasmaniensis*	Moderate	Moderate	Moderate

3.0 Predict the rate of impact per turbine per year for species likely to be affected

The rate of impact per turbine per year is not quantitatively estimated here given the lack of information on key relevant factors such as turbine avoidance. Rather, a risk-based assessment, similar to that developed by the Arthur Riley Institute (Lumsden *et al.* 2019) has been completed. The details of this assessment are included within the response to **Section 4.0**.

Where available, mortality estimates from other Australian wind farms has been considered for each aerial species within the responses below. Mortality estimates include data from two of 15 Victorian wind farms at which mortality monitoring has been undertaken and mortality rates for particular species determined (Moloney *et al.* 2019). However, it is emphasised that mortality rates are likely to vary considerably between wind farms, depending on a range of variables such as their proximity to key habitat features (e.g. important cave roosts), turbine size, landscape position and the inherent spatial variability in species abundance and utilisation of airspace (Richardson 2000, Drewitt and Langston 2006, Krijgsveld *et al.* 2009). For this reason, it is not advisable to extrapolate or predict mortality estimates provided in Moloney *et al.* (2019) for other wind farms such as the Project. However, the consideration of available mortality data is important when considering estimating relative risk for a species, such as in **Section 4.3**.

4.0 Justify predictions of likelihood of impact and rates of impact, with reference to relevant literature and other published sources of information

4.1 Risk Assessment Method

The relative risk of blade strike for the eleven species assessed here was estimated using two criteria to ascribe likelihood of risk and four criteria to ascribe consequence of risk (**Table 4.1, Table 4.2**). These six criteria were employed in a recent study conducted with the aim of developing a science-based approach to aid decision-making regarding turbine collision risk for birds and bats in Victoria (Lumsden *et al.* 2019). Each criterion was either adopted unchanged or was adjusted for the purposes of this current assessment as appropriate to ensure the particulars of each criterion was relevant to specific aspects of the Project such as geographic location. For the purposes of this assessment, Criterion A, C and F were slightly altered, Criterion B was substantially altered and the thresholds and spatial scale for Criterion E were adjusted.

Table 4.1 Criteria used to ascribe likelihood of risk

A	B
Known or likely frequency of flights within RSA height	Status or frequency of occurrence in the Project Area

Table 4.2 Criteria used to ascribe consequence of risk

C	D	E	F
Highly localised or concentrated population (for whole or part of lifecycle), such that siting of wind farm could have significant consequence to regional, national or international population	Impact on population relative to demographic capacity to replace fatalities (i.e. generalised combination of dispersal capacity of potential replacements, fecundity and generation time)	Known or estimated size of national or global population	Listed conservation status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the BC Act

Each species was ranked either low, moderate or high for each criterion depending on which is most appropriate in consideration of the assessed species' ecology and observed or predicted utilisation of the Study Area. Descriptions for each ranking are outlined in (**Table 4.3**).

Criterion A (flight height) was assessed by identifying the frequency of flights observed between 30 m and 200 m in the Study Area, and assessing this with consideration of observed and reported flight behaviour from elsewhere in Australia. Given that flight height data for bird and bat species in Australia is scant and observation data from pre-construction surveys at wind farms sites is largely unavailable, estimates of flight height require an adequate number of observations from the assessed site coupled with consideration of expert opinion on known flight behaviour for each species assessed. This Criterion is important as flight height is the primary variable through which a relative estimate of collision risk can be reached.

Criterion B (status in Project Area) was assessed by determining the status or estimating the frequency of occurrence in the Project Area. This Criterion is included as it is an essential component for estimating overall blade strike risk.

Criterion C (geographic population concentration) was assessed by estimating the degree to which a species' population may be concentrated due to site related factors such as geographic location, habitat type, proximity to important habitat or roost locations (i.e. significant wetlands, roost caves) and how this relates to the specific landscape in which the Project Area is located. Lumsden *et al*. (2019) noted that this criterion is intended to account for situations where the degree to which a taxon is geographically concentrated may influence the risk posed by the particular location of a wind farm. Where large flocks or aggregations are involved the concentration of individuals may be for short seasonal periods, but may nonetheless substantially heighten risk to a large portion of a species' total population. This is particularly important if a large proportion of a species' population passes through a localised area, such as a migratory corridor, over the course of each seasonal passage.

Criterion D (demographic resilience) was assessed through consideration of known aspects of each assessed species breeding biology and, most specifically, the nature of species' life-history traits. This criterion is included in the risk assessment as it is necessary to estimate the capacity to which a species' may replace individuals lost to mortality resulting from blade strike.

Criterion E (population size) is included to account for the variation in the significance of mortality of a given number of individuals between species as a result of the large variation in assessed species' national or global populations. This, when assessed in combination with Criterion D provides a measure through which the relative vulnerability of a species to loss of individuals can be estimated.

Criterion F (listed conservation status) refers to the status of bird and bat species listed under the EPBC Act or the BC Act. In instances where a species listing differs between Acts, for example one that is listed vulnerable under the EPBC Act and endangered under the BC Act the most threatened listing category is selected for the purposes of this assessment. Species listed as migratory and/or marine under the EPBC Act are not assigned a rank for this criterion.

Table 4.3 Descriptions of each ranking for Criterion A-F

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	Species that do not or rarely fly at RSA height	Species that rarely occur in the Project Area.	Species that are widely distributed within areas of suitable habitat and the habitat itself is relatively widely dispersed	Species that form breeding territories and that have a reasonable proportion of the population as nonbreeding ‘floaters’ that can rapidly replace breeding territorial adults if lost; species that may or may not form breeding territories and that are short-lived and have high fecundity; species that have capacity for long range or widespread juvenile or sub-adult dispersal	Total population (i.e. whether that corresponds to the national population of Australian endemics or a migrant’s global population) is estimated to number more than 20,000 individuals	Species not listed or listed as near threatened or data deficient under the EPBC Act or the BC Act
Moderate	Species which regularly fly below RSA height and occasionally fly at RSA height	Species that occasionally occur in, or occasionally move through the Project Area	Species that may be more widespread or have greater flexibility in the range of suitable habitat availability, but where a high proportion of their population is likely to be concentrated at sites where they do occur	Species with life-history characteristics that sit between the low and high descriptions here	Total population is estimated to number between 5,000 and 20,000 individuals	Species listed as vulnerable under the EPBC Act or the BC Act
High	Species in which a high proportion of flight activity is at RSA height	Species that regularly occur in, or regularly move through the Project Area	Bat species that have major aggregations at a few caves, or bird or bat species that have either very restricted distributions or those where a substantial proportion of a population may move through certain areas (i.e. migratory pathways)	Species that form breeding territories but where there is limited capacity for a lost breeding adult to be readily replaced; species that do not form breeding territories and that are long-lived and/or have low fecundity; species that may have short-distance juvenile or sub-adult dispersal capacity only	Total population is estimated to number less than 5,000 individuals	Species listed as endangered or critically endangered under the EPBC Act or the BC Act

4.2 Estimating overall risk

Estimates of overall risk for each assessed species were determined by following an approach similar to that employed by Lumsden *et al*. (2019) with the most notable exception being the difference in spatial scale for which resulting estimates of risk are intended to be relevant to (i.e. state-wide vs site-specific). Elements of the likelihood and consequence of collision were combined to form an overall qualitative risk category ('low'/'moderate'/'high') specific to the Project for the likelihood of collision and the consequence of collision. Likelihood of collision questions (Criterion A and B) and consequence of collision questions (Criterion C to F) were combined in a generally additive process to determine whether the overall likelihood and consequence of collisions was 'low', 'moderate' or 'high'.

For the overall estimate of **likelihood of collision** to be considered 'high', then at least Criterion A or Criterion B must be considered 'high' and neither could be considered 'low'. To be considered 'low', the rank for both these criteria must be 'low'. All other combinations are considered 'moderate'.

For the overall estimate of **consequence of collision**, the modal response of Criterion C, Criterion D, Criterion E and Criterion F was used as the estimate. In cases where responses are evenly spread between two risk ratings, the higher risk rating was designated. In cases where the risks were spread across all three levels, 'low'; ''moderate' and 'high', a 'moderate' risk was selected. The exception was in cases where the risk associated with criterion C for localised concentration was 'high'. It was considered that the consequences of high mortality due to wind turbine collisions for species that have a limited distribution and/or are highly concentrated is sufficiently large such that, if a species risk associated with this element was 'high', the consequences of collision should also be set to 'high', irrespective of the risks of the other criteria.

Once the overall risk levels for the likelihood and consequence of collision specific to the Project had been assigned for a species, the results were then placed into a risk matrix to determine the level of concern (**Table 4.4**). Five categories of risk were used, namely 'negligible', 'low', 'moderate', 'high' and 'severe', based on the combination of the scores for likelihood and consequence.

Table 4.4 Risk matrix

		Consequence of collisions		
		Low	Moderate	High
Likelihood of collisions	Low	Negligible	Minor	Moderate
	Moderate	Minor	Moderate	High
	High	Moderate	High	Severe

4.3 Assessment of likelihood and consequence of impact

4.3.1 Black falcon

4.3.1.1 Information on black falcon from Australian wind farms

There is one published record of blade strike of black falcon in the available literature (Wood 2015, Moloney *et al.* 2019). Over a two-year monitoring period from March 2013 to February 2015 one deceased black falcon was detected at Macarthur Wind Farm in south-western Victoria (Wood 2015). It was noted that the black falcon had a relatively low occurrence on the wind farm site having not been recorded during pre or post construction surveys, and was therefore unlikely to be significantly impacted by collision with wind turbines (at that wind farm) (Wood 2015). This case highlights that though a lack of records from pre-construction surveys at a wind farm may be interpreted as indicating a lower likelihood of blade strike, the risk of blade strike for highly mobile species considered to be 'unlikely to occur' or 'rare' in the region should not be discounted.

4.3.1.2 Status and flight behaviour in the Project Area

Black falcon were recorded on three occasions during bird utilisation surveys conducted in 2018/19 (**Figure 4.1**). All three observations were from February 2019 in open woodland on lower slopes of the landscape:

- 5 February 2019: one black falcon was observed foraging at RSA height at an average of 80 m AGL, 4 kms north-east of the Project Area at a control vantage point.
- 6 February 2019: a pair were observed circling at RSA height (at an average of 50 m AGL) on the western slopes of the Project Area, 800 m west of proposed turbine #84 before departing to the south.
- 8 February 2019: one bird was incidentally observed flying rapidly at 10 m AGL, 2 km west of the Project Area near the southern portions of the Project.

Black falcons were not recorded in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014).

Based on the broad habitat requirements, high mobility and wide-ranging distribution of this species, there is potential for this species to occur at any location within the Project Area. As with other raptors, the black falcon is likely to spend a high proportion of time at RSA height whilst flying within the Project Area.

4.3.1.3 Likelihood and Consequence of Impacts

The overall risk rating for black falcon is high, based on a high likelihood and moderate consequence of collisions (**Table 4.5**). The high likelihood of collisions is based on this species' flight behaviour though it is noted that given black falcon only occasionally occur in the Project Area the rate of collisions is likely to be relatively low. Rationale for responses to each criterion is as follows:

a) A high proportion of the black falcon's flight activity is at RSA height

b) The black falcon occasionally occurs in the Project Area.

c) The black falcon is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the black falcon overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Marchant and Higgins 1993).

e) In 2009, the national population of black falcon was estimated between 1,000 to 10,000 individuals, roughly equating to 670 – 6,700 mature individuals, although the data quality is reported as being poor (Birdlife International 2020). Hence, Criterion E is conservatively assigned 'high'.

f) The black falcon is listed as vulnerable in NSW under the BC Act.

The black falcon's risk rating of high largely reflects the potentially high consequence of low frequencies of blade strike in the Project Area.

Table 4.5 Black falcon risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X			
Moderate		X		X		X
High	X				X	
Risk Rating						
Likelihood	High	**Consequence**	Moderate	**Risk Rating**	High	

4.3.2 Little eagle

4.3.2.1 Information on little eagle from Australian wind farms

Moloney *et al.* (2019) reported one record of blade strike of little eagle from post-construction mortality monitoring of 15 wind farms in Victoria from 2003 to 2018. Smales (2014), reported two records of blade strike of little eagle from eight wind farms in south-eastern Australia (i.e. Victoria and South Australia). It is likely that these reports are referring to the same record of blade strike in Victoria.

4.3.2.2 Status and flight behaviour in the Project Area

Little eagle were recorded twice in the Project Area during surveys conducted in 2018/19 (**Figure 4.1**):

- 9 November 2018: one bird was observed foraging approximately 750 m north-east of proposed turbine #18 at 150 m AGL.
- 1 February 2019: one bird was observed flying east to west over the main ridge, at approximately 60 m AGL at proposed turbine #80.

Little eagles were not recorded in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014).

Based on the broad habitat requirements, high mobility and wide-ranging distribution of this species, there is potential for this species to occur at any location within the Project Area. As with other raptors, the little eagle is likely to spend a high proportion of time at RSA height whilst flying within the Project Area.

4.3.2.3 Likelihood and Consequence of Impacts

The overall risk rating for little eagle is high, based on a high likelihood and moderate consequence of collisions (**Table 4.6**). The high likelihood of collisions is based on this species' flight behaviour though it is noted that given little eagle only occasionally occur in the Project Area the rate of collisions is likely to be relatively low. Rationale for responses to each criterion is as follows:

a) A high proportion of the little eagle's flight activity is at RSA height

b) The little eagle occasionally occurs in the Project Area.

c) The little eagle is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the little eagle overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Marchant and Higgins 1993).

e) In 2009, the population of little eagle was estimated to number 10,000 to 100,000 individuals, based upon an estimate made by Ferguson and Christie (2001), although the data quality is listed as poor (Birdlife International 2020). Given the uncertainty of this estimate and the decline of little eagle in NSW (Barrett et al. 2007) and the ACT (Olsen and Fuentes 2005) Criterion E was assigned 'moderate' (based on the lower population estimate).

f) The little eagle is listed as vulnerable in NSW under the BC Act.

The little eagle's risk rating of high largely reflects the potentially high consequence of low frequencies of blade strike in the Project Area.

Table 4.6 Little eagle risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X			
Moderate		X		X	X	X
High	X					
Risk Rating						
Likelihood	High	**Consequence**	Moderate	**Risk Rating**	High	

4.3.3 Wedge-tailed eagle

4.3.3.1 Information on wedge-tailed eagle from Australian wind farms

The wedge-tailed eagle is commonly reported during mortality monitoring events at wind farms in Australia. Moloney *et al.* (2019) report wedge-tailed eagle as the second most frequently recorded bird species found dead during monitoring from 2003 to 2018 across 15 wind farms in Victoria, with 58 carcasses detected and equating to 10% of all birds found. Using this data, Moloney *et al.* (2019) calculated mortality estimates of 0.06 (95% CI: 0.02 – 0.41) and 0.1 (95% CI: 0 - 0.2) individuals per turbine per year at two Victorian wind farms.

At two wind farms in north-western Tasmania, 18 wedge-tailed eagle carcasses were recorded during monitoring conducted for three and six years at Bluff Point Wind Farm and Studland Bay Wind Farm respectively (Hull *et al.* 2013). This particular monitoring program modelled a mortality estimate of 1.5 and 1.1 collisions per annum at Bluff Point (37 turbines) and Studland Bay (25 turbines). A 95% turbine avoidance rate closely approximated the observed mean annual mortality rate of 1.6 and 1.1 individuals per annum at each wind farm respectively (Smales *et al.* 2013).

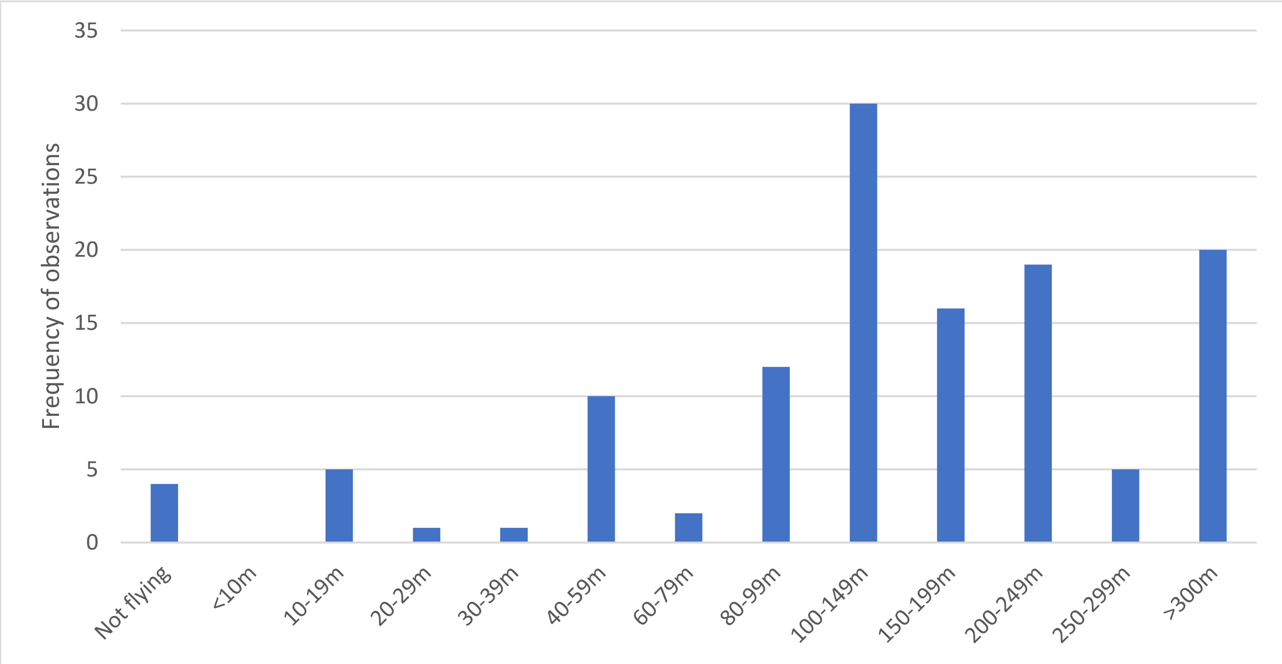
Wedge-tailed eagles are known to have collided with wind turbines in south-east NSW however the total number of fatalities detected in this region is not publicly available (BCD unpublished data). Six wedge-tailed eagle carcasses were recorded under turbines at Gullen Range Wind Farm during monthly monitoring of 30-32 (of 73 turbines) conducted from January – June 2015 (BLA, 2016).

4.3.3.2 Status and flight behaviour in the Project Area

Wedge-tailed eagle were observed throughout the Project Area and recorded on 125 occasions during the 2018/19 bird utilisation surveys (**Figure 4.2**). No nests were recorded in the Project Area during these surveys, though one active nest was recorded on the boundary of the Project Area 1.5 km south-east of proposed turbine #87. NGH (2014) recorded wedge-tailed eagle on 14 occasions in the Project Area during bird utilisation surveys conducted during 2011 - 2013. One inactive wedge-tailed eagle nest was recorded in the central section of the Project Area, resulting in proposed turbine #91 being removed from the layout and proposed turbine #92 being shifted south (NGH 2014).

A summary of wedge-tailed eagle observations made during the 2018/19 survey is presented below:

- 64% (80/125) of observations were of individuals, 29% (36/125) were of pairs, 6% (7/125) were of three birds and less than 2% (2/125) were of four birds.
- Wedge-tailed eagles were recorded in flight on 121 occasions:
  - Observed flights were almost exclusively of individuals or pairs soaring, displaying or circling above 40 m AGL (92% of observations) (Error! Reference source not found.).
  - 74% of flights (90/121) were recorded between 30 – 200 m.
- Of the vantage point sites surveyed during each season (five sites), wedge-tailed eagles were recorded during 60% (24/40) of surveys (Umwelt 2018 /19).



Graph 4.1 Frequency of wedge-tailed eagle observations in each height class.

Wedge-tailed eagle observations were distributed fairly consistently between the three 'impact' vantage points, lower at one 'control' site VPC03 and higher 'control' site VPC04 (**Table 4.7**). The higher number of observed wedge-tailed eagle at VPC04, may be attributed to landscape factors and the layout of elevated ridges surrounding the observer location. VPC03's position differed markedly in that it was positioned on a prominent high point along the dominant ridgeline of the Project Area and there were no other elevated areas (e.g. hills or ridges) within detection distance to the east or west.

Wedge-tailed eagle were regularly recorded regardless of wind speed at the three 'impact' vantage points although it is noted that no surveys were conducted in the early morning prior to thermals becoming active, meaning that very few surveys were conducted in still conditions (**Table 4.8**).

Table 4.7 Summary of wedge-tailed eagle observations at 'impact' and 'control' vantage survey points

	VPI01	VPI03	VPI04	VPC03	VPC04
Proportion of surveys detected	50% (4/8)	88% (7/8)	50% (4/8)	25% (2/8)	75%(6/8)
Number of individuals observed	13	14	12	6	24

Table 4.8 Summary of wedge-tailed eagle observations at vantage point surveys by recorded wind speed

	<11km/h	11-28km/h	29-38km/h	39-61km/h
Proportion of surveys detected	64% (7/11)	43% (6/14)	75% (9/12)	66% (2/3)
Number of individuals observed	20	14	24	11
Number of records / survey	1.8	1.0	2	3.7

4.3.3.3 Likelihood and Consequence of Impacts

The overall risk rating for wedge-tailed eagle is moderate, based on a high likelihood and low consequence of collisions (**Table 4.9**). The rationale for responses to each criterion is as follows:

a) A high proportion of the wedge-tailed eagle's flight activity is at RSA height.

b) The wedge-tailed eagle is a common resident in the Project Area.

c) The wedge-tailed eagle is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the wedge-tailed eagle overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D however overall they average out between the two and hence Criterion D is assigned 'moderate' (Marchant and Higgins 1993).

e) The total population of wedge-tailed eagle is described as very large by Birdlife International (2020) and given this species very large distribution (c. 10.6 million km^2) the total population is likely to exceed 20,000 individuals.

f) The subspecies of wedge-tailed eagle that occurs in the Project Area is not listed as threatened under the EPBC Act or the BC Act.

The wedge-tailed eagle's risk rating of moderate reflects the moderate level of impact that a potentially high frequency of blade strike in the Project Area is likely to have on this species' total population.

Table 4.9 Wedge-tailed eagle risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate				X		
High	X	X				
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	Moderate	

4.3.4 Superb parrot

4.3.4.1 Information on superb parrot from Australian wind farms

There are no records of blade strike of superb parrot in the available literature from Victoria (Moloney *et al.* 2019) which is unsurprising given the lack of wind farms in the superb parrot's range in north-eastern Victoria. There are no records of blade strike of superb parrot in the available data collected in south-eastern NSW to date (BCD unpublished data). In south-eastern NSW, there are three operational wind farms which may present a risk to superb parrot, namely Cullerin Range, Gunning and Gullen Range. These three wind farms are located at the current eastern edge of the superb parrot's range in the Southern Tablelands region.

Given the location of the Project and considering the construction of the Bango Wind Farm an increase in the risk of blade strike to superb parrot in south-eastern NSW is likely to result. Research to be conducted on the movement of superb parrots in the Yass region including at the under construction Bango Wind Farm is likely to improve understanding of the susceptibility of this species to blade strike and indirect impacts resulting from the operation of turbines (Rayner 2019). Potential cumulative impacts on superb parrot from wind farms in this region are discussed in **Section 6.0**.

4.3.4.2 Status and flight behaviour in the Project Area

Superb parrots were frequently recorded in box-gum woodland in the lower-lying parts of the landscape immediately west of the Project Area during the 2011-13 surveys (NGH 2014) and the 2018/19 surveys. The species was observed in various locations in the Project Area during both the 2011/2013 and 2018/2019 survey periods. The majority of records during both surveys were concentrated in an area in the southern portion of the Project Area.

During 2011-2013, NGH (2014) documented regular superb parrot flights near proposed turbines #106, 107, 109 and 110 where an observer watched activity from a dedicated vantage point. In response to this finding, proposed turbines #106, 107, 109 and 110 were removed from the proposed layout. Additional records, including breeding pairs were detected to the north of proposed turbines #119, 120, 122, 124, 125 and 142. The majority of superb parrot records during 2018/2019 were also recorded within this area.

Superb parrots were recorded on 30 occasions during 2018/2019 bird surveys (**Figure 4.1**), with survey effort focussed immediately north (in the range of approximately 200 to 1000 m north) of proposed turbines #119, 120, 122, 124, 125 and 142. These six proposed turbines are likely to pose the highest risk to superb parrots in the Project Area. Active breeding was not detected during 2018/19, however, given surveys were generally restricted to a specific area in which transects designed to monitor movements were walked, breeding in nearby suitable habitat may have gone undetected.

Other notable records made during the 2018/2019 survey, include two records from the northern portion of the Project Area (all other records for the species in the Project Area during 2018/19 were from the southern areas) and one from control site VPC04 to the north-east of the Project Area. These records are detailed below:

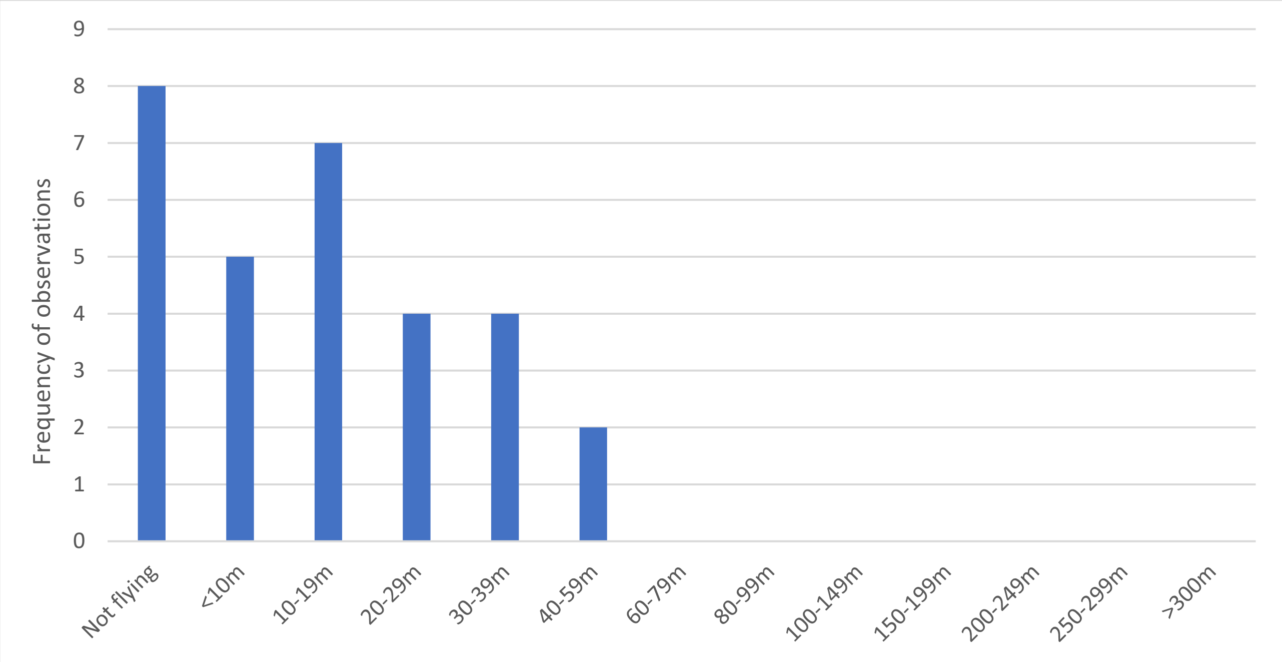
- 30 January 2019: three superb parrots were observed flying in a northerly direction at 15 m AGL in the north-eastern section of the Project Area 500 m east of proposed turbine #22 and 700 m west of proposed turbine #136.
- 30 January 2019: a group of five superb parrots were observed perched in the far northern section of the Project area, 600 metres west of proposed turbine #4.
- 30 January 2019: one individual was recorded at a ‘control’ vantage point north-east of the Project Area (VPC04) flying north-east at 40 m AGL.

Further to the above, ten incidental superb parrot observations (2018/19 surveys) were made in the vicinity of Dalton Road and Little Plains Road approximately 1-2.5 km west of the Project Area. These observations confirm similar records made NGH (2014) during 2011-2013 in this area.

Of the records made the 2018/19 surveys, superb parrots were observed in flight on 22 occasions (**Graph** 4.2). A summary of these observations is provided below:

- 18% (4/22) of flights were of individuals or flocks flying between 20-29m AGL, 18% (4/22) at 30-39m AGL and 9% (2/22) at 40-49m AGL whilst the remaining 55% (12/22) of flights were below 20 m AGL.
- In the southern section of the Project Area superb parrot were observed in flight on 14 occasions. 43% (6/14) of flights were below 20 m AGL, 29% (4/14) were at 20-29 m AGL, 21% (3/14) were at 30-39 m and one was at 40 m AGL.

Based on observations from elsewhere in their range it is expected that the observed maximum flight of 40 m AGL does not correspond with the maximum flight height of this species. Further, the true frequency of flights above 20 m AGL relative to the number of flights below 20 m AGL is likely to be higher than depicted in **Graph 4.2**.



Graph 4.2 Frequency of superb parrot observations in each height class

4.3.4.3 Likelihood and Consequence of Impacts

The overall risk rating for superb parrot is high, based on a high likelihood and moderate consequence of collisions (**Table 4.10**). Rationale for responses to each criterion is as follows:

a) The superb parrot regularly flies below RSA height and occasionally flies at RSA height

b) The superb parrot regularly occurs in the Project Area.

c) The superb parrot's range is relatively restricted and the extent of its habitat has been reduced substantially since European settlement. Superb parrot are known to congregate in areas of remaining habitat particularly in the south-eastern portion of their range during spring and summer. Furthermore, a large proportion of their total population occurs and moves through the region in which the Project Area is located.

d) The life-history characteristics of the superb parrot overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins 1999)

e) There are several estimates of total superb parrot population size. Higgins (1999) estimated that there were less than 5,000 breeding pairs, Garnett and Crowley (2000) estimated a total of 5000 adult birds, Baker-Gabb (2011) estimated a total of 5,000 to 8,000 individuals and Garnett et al. 2011 estimated there to be well over 10,000 individuals. Based on these population estimates Criterion E was assigned 'moderate'.

f) The superb parrot is listed as vulnerable under the EPBC Act and the BC Act.

Table 4.10 Superb parrot risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low						
Moderate	X		X	X	X	X
High		X				
Risk Rating						
Likelihood	High	**Consequence**	Moderate	**Risk Rating**	High	

4.3.5 White-throated needletail

4.3.5.1 Information on white-throated needletail from Australian wind farms

The white-throated needletail is particularly vulnerable to blade strike (Hull *et al.* 2013). Five birds have been found during post-construction mortality monitoring conducted at 15 wind farms in Victoria from 2003 to 2018 (Moloney *et al.* 2019). There are 11 records of blade strike of white-throated needletail at both Bluff Point Wind Farm and at Studland Bay Wind Farm in north-west Tasmania (Hull *et al.* 2013). White-throated needletail are known to have collided with wind turbines in south-east NSW, with much of the data collected in this region being not publicly available (BCD unpublished data). Despite this, there are six records of deceased white-throated needletail at Capital Wind Farm from 2012/13 on the Atlas of Living Australia.

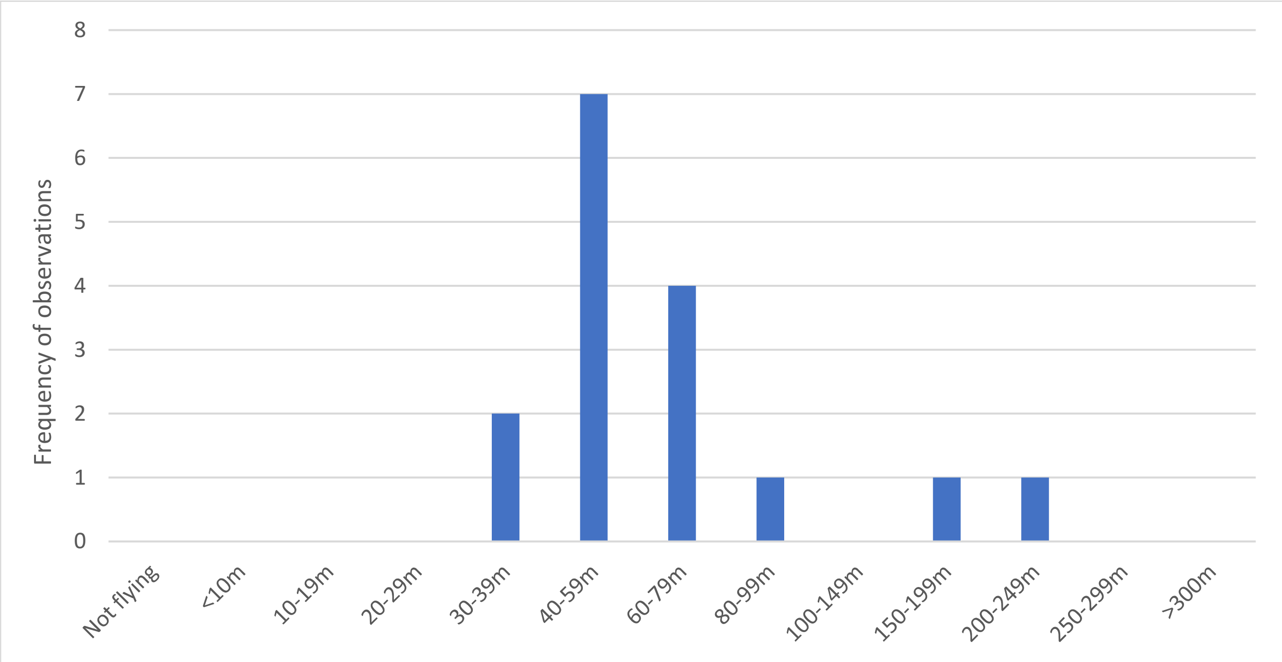
4.3.5.2 Status and flight behaviour in the Project Area

White-throated needletails were recorded on 16 occasions in the Project Area in February/March 2019 (**Figure 4.1**). These observations were not concentrated in any particular section of the Project Area, although the majority were instances of foraging above or moving through the higher sections of the Project Area (i.e. 700 m above sea level). White-throated needletail were not recorded in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014).

A summary of the white-throated needletail observations made within the Project Area is presented below:

- 4-6 February 2019: a flock of 24 individuals, 500 m west of proposed turbine #69 was observed circling at approximately 200 m AGL. There were a further seven observations during the next two days including an observation of 13 birds flying south at 60 m AGL near proposed turbine #120 in the southern section of the Project Area and 15 birds flying east at the same height above Grassy Creek Road in the northern section of the Project Area.
- 13 – 15 February 2019: six observations, including one of a flock of 55 individuals flying around proposed turbines #80 and #82 at RSA height.
- 14 February 2019: 41 individuals were observed flying directly along the ridge in a southerly direction at RSA height over a period of 15 minutes near three proposed turbines removed from the layout (#102, 103 and 104).
- 8 March 2019: Two observations comprising five and six individuals, observed at a control vantage point (VPC03) north of Blakney Creek South Road and between proposed turbines #83 and #143.

Each observation of white-throated needletails in the Project Area was of individuals or flocks flying at RSA height (**Graph 4.3**). The majority of observations were of birds flying between 40 - 80 m AGL with 83% (165/200) of observed individuals occurring within this height range. Although not recorded during the surveys, white-throated needletails would also forage below and above RSA in the Project Area.



Graph 4.3 Frequency of observations of white-throated needletail in each height class.

4.3.5.3 Likelihood and Consequence of Impacts

The overall risk rating for white-throated needletail is high, based on a high likelihood and moderate consequence of collisions (**Table 4.11**). The rationale for responses to each criterion is as follows:

a) A high proportion of the white-throated needletail's flight activity is at RSA height.

b) Based on the observations of this species in the Project Area, Criterion B could either be assigned 'moderate' or 'high' because this species could either be an occasional or a regular seasonal visitor in the Project Area each year. Regardless, because a rating of 'low' for Criterion B is not considered, the overall likelihood of collision is automatically deemed 'high' due to the 'high' rating assigned for Criterion A.

c) Although the white-throated needletail has a very large range it is noted that because a large proportion of this species' population may occur at specific preferred foraging areas or use particular migratory paths there is a high degree of variability in the likelihood of collisions between locations across its distribution in eastern Australia.

d) The location of the Project Area in the western section of its range in south-eastern NSW suggests that it is unlikely that a high proportion of this species' population occurs in the Project Area annually. However, observations from the Project Area indicate that the NNW-SSE aligned ridge running the length of the Project Area is potentially an important landscape feature in a regional context for white-throated needletail.

e) The life-history characteristics of the white-throated needletail overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins 1999).

f) The total population of white-throated needletail has not been estimated (Birdlife International 2020). The population size of the nominate subspecies that migrates to Australia is likely to comprise approximately 10,000 individuals (DoE 2015).

g) The white-throated needletail is listed as vulnerable and migratory under the EPBC Act.

Table 4.11 White-throated needletail risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low						
Moderate		X	X	X	X	X
High	X					
Risk Rating						
Likelihood	High	**Consequence**	Moderate	**Risk Rating**	High	

4.3.6 White-fronted chat

4.3.6.1 Information on white-fronted chat from Australian wind farms

There are no published records of blade strike of white-fronted chats in the available literature in Victoria (Moloney *et al.* 2019), south-east New South Wales (BCD unpublished data) or in north-west Tasmania (Hull *et al.* 2013). This is despite having a wide distribution in southern Australia, a preference for open landscapes in which the majority of wind farms are situated and a tendency to occasionally fly above the typical minimum RSA height. Given the survey effort of post-construction monitoring to date, scavenger rates in open landscapes and the small size of this species amongst other factors it is plausible that instances of blade strike have gone undetected at Australian wind farms.

A review of literature identified that the species may actively avoid turbines, with an observation of turbine avoidance from Codrington Wind Farm in south-western Victoria. Meredith *et al.* (2002) reported a 100% turbine avoidance rate for the species at this location. However, given that the context of the situation in which this observation was made is unknown (i.e. the survey effort, number of observed flights, habitat type and all other relevant factors are unspecified) little can be drawn from this observation other than the conclusion that white-fronted chat do indeed avoid turbines (though the question of the rate at which they do remains unanswered).

4.3.6.2 Status and Flight Behaviour in the Project Area

White-fronted chats were regularly recorded in the northern half of the Project Area during bird utilisation surveys conducted in 2018/19, from four distinct areas of occupancy (**Figure 4.1**). These areas supported suitable habitat for the species, being open areas containing isolated patches of low bracken. Across all surveys conducted during 2018/2019, white-fronted chats were recorded on 86 occasions, occurring in flocks of up to 28 individuals. 90% of observations were recorded in the particular areas highlighted in **Figure 4.1**, including one record of an active nest.

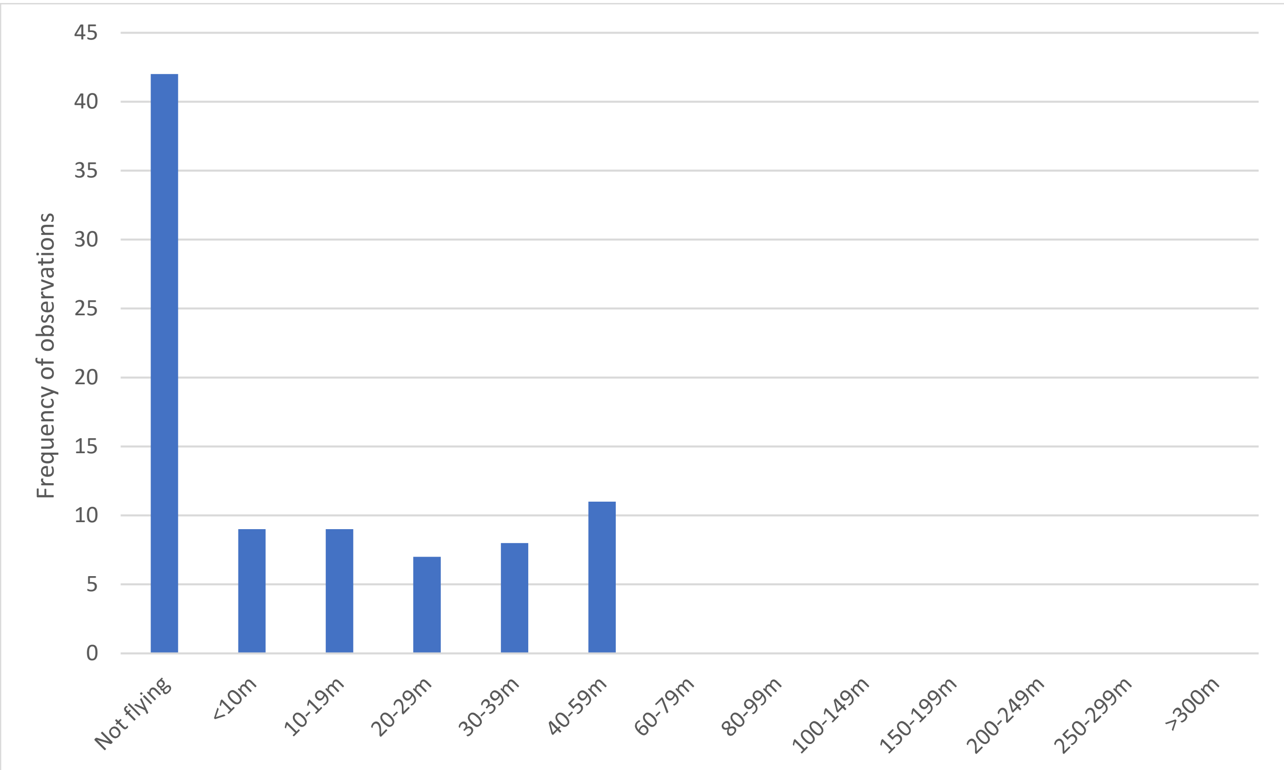
White-fronted chats were recorded on four occasions in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014).

Based on the extent of occupied habitat and the proportion of potential habitat surveyed it is likely that white-fronted chats most frequently occur at 25 proposed turbine locations in the Project Area (**Figure 4.1, Table 4.12**). Movement between the four areas of occupancy is considered likely, given the relatively short distances and absence of barriers. For this reason, the occurrence of white-fronted chat is unlikely to be restricted to these 25 identified proposed turbine locations alone, although abundance and flight records appear to be greatest in such areas throughout the 2018/19 surveys.

Table 4.12 Proposed turbines located within likely white-fronted chat area of occupancy

Area	Turbines
North-western area	1, 2, 3, 4, 5, 7, 9, 151
North-eastern area	18, 21, 22, 25, 26, 30, 31, 36, 39, 135, 136, 137, 138
High Rock Rd property	73, 74,
Flakney Creek Rd area	82, 83

Whilst white-fronted chats tended to spend a considerable amount of time foraging on the ground or perched on low shrubs or fences (49% of observations), the species was also regularly recorded flying at or above 30 m AGL in the Project Area (**Graph 4.4**). On eight occasions (18% of observed flights), individuals or flocks were recorded flying at between 30-39 m AGL and on 11 occasions (25% of observed flights), they were recorded between 40-59 m AGL. Observed flights at RSA height were typically undertaken by individuals, pairs or larger groups across a distance of several hundred metres at a time. Of the observed flights at and above 40 m AGL three were of a single bird, six were of pairs and the remaining two comprised flocks of 10 and 16 individuals.



Graph 4.4 Frequency of observations of white-fronted chat in each height class.

4.3.6.3 Likelihood and Consequence of Impacts

The overall risk rating for white-fronted chat is moderate, based on a high likelihood and low consequence of collisions (**Table 4.13**). The rationale for responses to each criterion is as follows:

a) The white-fronted chat regularly flies below RSA height and occasionally flies at RSA height.

b) The white-fronted chat is a resident in the Project Area and frequently occurs in areas where turbines are proposed.

c) The white-fronted chat is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The white-fronted chat is not long-lived, has relatively high fecundity and a high capacity to replace individuals lost (Higgins et al. 2001).

e) There are no estimates of the total population of white-fronted chat (Birdlife International 2020) however given their large area of occupancy its population is likely to exceed 20,000 individuals.

f) The white-fronted chat is listed as vulnerable in NSW under the BC Act.

Table 4.13 White-fronted chat risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X	X	X	
Moderate	X					X
High		X				
Risk Rating						
Likelihood	High	Consequence	Low	Risk Rating	**Moderate**	

4.3.7 Brown treecreeper

4.3.7.1 Information on brown treecreeper from Australian wind farms

There are no published records of blade strike of brown treecreepers in the available literature in Victoria (Moloney *et al.* 2019) or south-east New South Wales (BCD unpublished data), though it is noted that the majority of wind farms monitored in Victoria are on the south-western edge or outside of this species' distribution.

4.3.7.2 Status and flight behaviour in the Project Area

Brown treecreepers were not recorded in the Project Area in 2018/19 despite extensive surveys across suitable habitat. Brown treecreeper were recorded on six occasions in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014). All observations were of birds near proposed turbines #102, 103 and 104 (which have since been removed from the layout). Each observation was of birds below 20 m AGL (NGH 2014).

4.3.7.3 Likelihood and Consequence of Impacts

The overall risk rating for brown treecreepers is minor, based on a low likelihood and moderate consequence of collisions (Table 4.14). The rationale for responses to each criterion is as follows:

a) Based on observations from the Project Area and knowledge of this species' flight behaviour from elsewhere, the brown treecreeper is unlikely to fly at RSA height in the Project Area.

b) The surveys conducted in 2011-2013 and 2018/19 indicate that the brown treecreeper is currently an uncommon/rare visitor or resident in the Project Area. This species has declined considerably in the greater region during the past three decades (Reid 1999, Trail and Duncan 2000, COG 2020) to the point that certain sites that were formerly occupied are now irregularly visited or no longer support brown treecreeper (e.g. as documented in parts of the ACT) (COG 2020).

c) The brown treecreeper is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The brown treecreeper is not long-lived and has relatively high fecundity, though appears to have a limited capacity to replace individuals lost in certain fragmented landscapes such as the region in which the Project Area is located (Higgins et al. 2001).

e) The population size of the brown treecreeper is unknown (Birdlife International 2020), though it is likely to exceed 20,000 individuals based on the size of its distribution in eastern Australia (c. 3.3 million km^2). Due to the estimated extent of occurrence of the south-eastern subspecies (*C. p melanotus*) of approximately 600,000 km2 (Garnett et al. 2011) and its decline Criterion E is conservatively assigned 'moderate' because the population of this subspecies may number between 5,000 and 20,000 individuals.

f) The brown treecreeper is listed as vulnerable in NSW under the BC Act.

Table 4.14 Brown treecreeper risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X	X	X			
Moderate				X	X	X
High						
Risk Rating						
Likelihood	Low	**Consequence**	Moderate	**Risk Rating**	Minor	

4.3.8 Varied sittella

4.3.8.1 Information on varied sittella from Australian wind farms

There are no published records of blade strike of varied sittellas in the available literature in Victoria (Moloney *et al.* 2019) or south-east New South Wales (BCD unpublished data).

4.3.8.2 Status and flight behaviour in the Project Area

Varied sittellas were observed on eight occasions in the Project Area in 2018/19 (**Figure 4.1**) comprising three records in the far southern section of the Project Area, four records in the central section and one in the northern section. Of these eight observations, two were at proposed turbines #80 and 150 in the central section of the Project Area. Observations were not concentrated in any particular area of the Project Area. Varied sittella may occur in any area of woodland (including open woodland supporting scattered paddock trees) or dry forest in the Project Area.

All observations during 2018/19 were of groups foraging or moving between paddock trees at or below canopy height. A total of 1/6 (17%) flight observations were of birds flying at 10 m AGL, 2/6 (33%) at 15 m AGL and 3/6 (50%) at 20 m AGL. Varied sittellas were recorded on four occasions between 0 – 20 m AGL in the Project Area during bird utilisation surveys conducted during 2011-2013 (NGH 2014).

4.3.8.3 Likelihood and Consequence of Impacts

The overall risk rating for varied sittella is minor, based on a moderate likelihood and low consequence of collisions (Table 4.15). The rationale for responses to each criterion is as follows:

a) Based on observations from the Project Area and knowledge of this species' flight behaviour from elsewhere varied sittella are likely to rarely fly at RSA height in the Project Area.

b) The varied sittella is a resident in the Project Area.

c) The varied sittella is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The varied sittella is not long-lived, has relatively high fecundity and a high capacity to replace individuals lost (Higgins and Peter 2002).

e) The total population of varied sittella is unknown (Birdlife International 2020) though it is likely to exceed 20,000 individuals given its very large distribution across the Australian mainland (c. 9.2 million km2) (Birdlife International 2020).

f) The varied sittella is listed as vulnerable in NSW under the BC Act.

Table 4.15 Varied sittella risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X		X	X	X	
Moderate						X
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	Minor	

4.3.9 Painted honeyeater

4.3.9.1 Information on painted honeyeater from Australian wind farms

There are no published records of blade strike of painted honeyeaters in the available literature in Victoria (Moloney *et al.* 2019) or south-east New South Wales (BCD unpublished data). The majority of wind farms monitored in Victoria are on the south-western edge or outside of this species' distribution.

4.3.9.2 Status and flight behaviour in the Project Area

Painted honeyeaters were not recorded in the Project Area in 2018/19 despite extensive surveys in suitable habitat. Painted honeyeaters were recorded on seven occasions in the Project Area during bird utilisation surveys conducted during November 2013 (NGH 2014). Six of these observations were of birds in flowering mistletoe in an area of box-gum woodland in the southern section of the Project Area, west of four proposed turbines (#106, 107, 109 and 110) that have since been removed from the layout. It was estimated that 10-12 individuals were present in this particular area during November 2013 (NGH 2014). The southernmost record is approximately 800 m north of proposed turbine #120. The other observation during November 2013 was from an area of box-gum woodland in the central section of the Project Area approximately 800 m north-west of proposed turbine #143. Flight data was only recorded for two observations. Both flight records were of individuals below 10 m AGL (NGH 2014).

4.3.9.3 Likelihood and Consequence of Impacts

The overall risk rating for painted honeyeater is moderate, based on a moderate likelihood and moderate consequence of collisions (Table 4.16).The rationale for responses to each criterion is as follows:

a) Based on observations from the Project Area and knowledge of this species' flight behaviour from elsewhere, painted honeyeaters are likely to regularly fly below and occasionally fly at RSA height in the Project Area.

b) The painted honeyeater is an uncommon/rare visitor, most likely to occur during spring and summer when mistletoe is flowering in the Project Area.

c) The painted honeyeater is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The painted honeyeater is not long-lived, has relatively high fecundity and a high capacity to replace individuals lost (Higgins et al. 2001).

e) Garnett et al. (2011) estimated a declining population of between 2,500 and 10,000 mature individuals, roughly equivalent to 3,750 - 15,000 individuals in total. Taking a precautionary approach, the lower estimate has been accepted and Criterion E is assigned 'high'.

f) The painted honeyeater is listed as vulnerable under the EPBC Act and the BC Act.

Table 4.16 Painted honeyeater risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low		X	X	X		
Moderate	X					X
High					X	
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	Moderate	

4.3.10 Dusky woodswallow

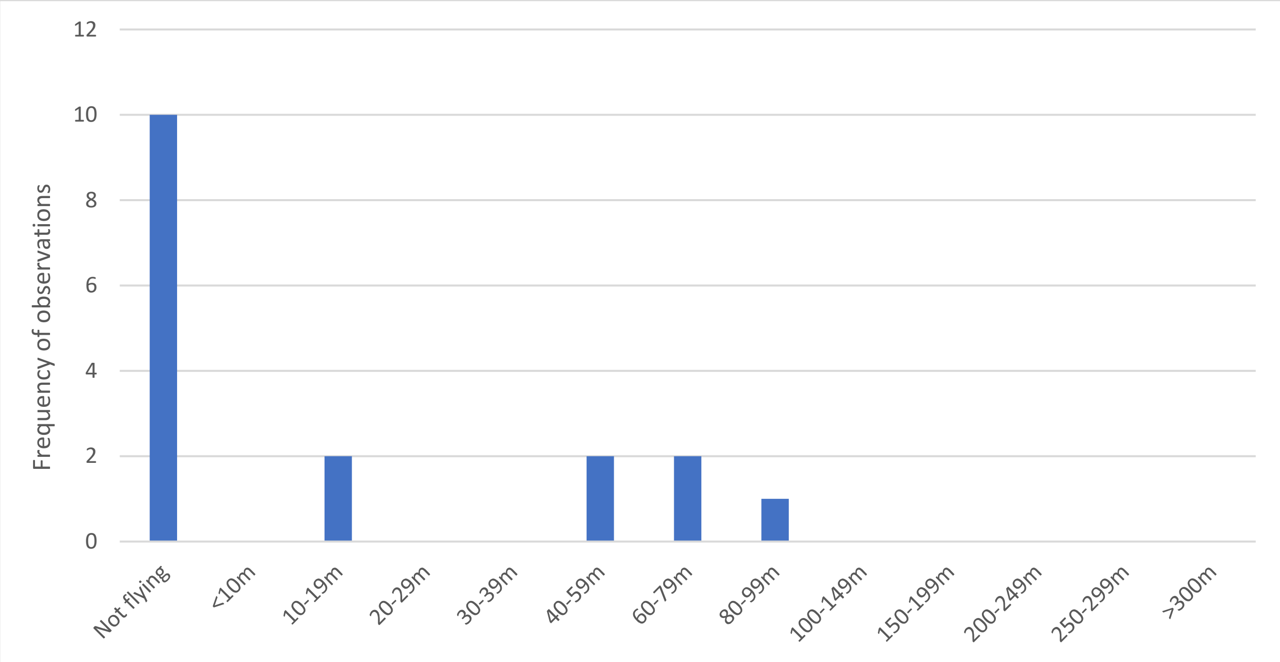
4.3.10.1 Information on dusky woodswallow from Australian wind farms

Moloney *et al.* (2019) reported one record of blade strike of dusky woodswallows at Victorian wind farms from post-construction mortality monitoring from 2003 to 2018. Smales (2014) also reported one record of blade strike from a total of eight wind farms in south-eastern Australia (i.e. Victoria and South Australia). It is likely that these reports are referring to the same record.

4.3.10.2 Status and flight behaviour in the Project Area

Dusky woodswallows were recorded on 17 occasions in the Project Area in 2018/19 (**Figure 4.1**). These observations were not concentrated in any particular section of the Project Area although dusky woodswallows were more frequently seen at a vantage survey point (VPI04) at proposed turbine #31 than at any other vantage point of transect. Dusky woodswallows were recorded on three occasions in the Project Area during bird utilisation surveys conducted during 2011 - 2013 (NGH 2014).

Of all observations in 2018/2019, 58% (10/17) were of dusky woodswallows perched, whilst 71% (5/7) of flight records comprised flocks or individuals foraging at RSA height between 40-100 m AGL (**Graph 4.5**).



Graph 4.5 Frequency of observations of dusky woodswallow in each height class.

4.3.10.3 Likelihood and Consequence of Impacts

The overall risk rating for dusky woodswallow is moderate, based on a high likelihood and low consequence of collisions (**Table 4.17**). The rationale for responses to each criterion is as follows:

a) A high proportion of the dusky woodswallow's flight activity is at RSA height.

b) The dusky woodswallow regularly occurs in the Project Area.

c) The dusky woodswallow is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The dusky woodswallow is not long-lived, has relatively high fecundity and a high capacity to replace individuals lost (Higgins et al. 2006).

e) The total population of the dusky woodswallow is unknown (Birdlife International 2020) though it is likely to exceed 20,000 individuals.

f) The dusky woodswallow is listed as vulnerable in NSW under the BC Act.

Table 4.17 Dusky woodswallow risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X	X	X	
Moderate						X
High	X	X				
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	Moderate	

4.3.11 Large bent-winged bat

4.3.11.1 Information on large bent-winged bat from Australian wind farms

There are no published records of blade strike of large bent-winged bats in the available literature in Victoria (Moloney *et al.* 2019) or south-east New South Wales (BCD unpublished data). The majority of wind farms monitored to date in Victoria are located outside of this species' distribution. There are eight published records of blade strike of the closely related southern bent-winged bat in the available literature in Victoria (Moloney *et al.* 2019). A mortality model for southern bent-winged bat generated a mortality rate estimate of 0.1 individuals per turbine per year (95% CI 0-0.5) for one particular wind farm (Moloney *et al.* 2019).

Large bent-winged bats are known to have collided with wind turbines in south-east NSW however data collected in this region is not publicly available (BCD unpublished data).

4.3.11.2 Status and flight behaviour in the Project Area

Three confirmed large bent-winged bat calls were recorded during the 2018/19 survey. Each of these records were from ground level, 250 m south-west of proposed turbine #124 (**Figure 4.3**). During the November 2011 and April 2012, 41 large bent-winged bats were recorded in the Project Area (NGH 2014). The majority of these calls were from the central section of the Project Area between proposed turbines #80 and #143 (NGH 2014). The species was also recorded in the southern section of the Project Area near the removed turbines #104 and 105 and in the northern section of the Project Area near proposed turbines #9 and #25.

As very few confident large bent-winged bat identifications were made from the data collected in 2018/19, unresolved calls that may have been from large bent-winged bats were pooled to create a "possible large bent-winged bat" dataset (**Appendix E1**). This allowed for the comparison of data within and outside the bent-winged bat migration period.

A total of 1107 sample nights were included in the analyses from 30 different sites. Overall, there was no spike in activity during the autumn migration season. The data suggest that whilst the Project Area is located within an area that large bent-winged bats migrate through (Dwyer 1969) there is no evidence that a highly utilised autumn migratory path intersects the Project Area.

4.3.11.3 Likelihood and Consequence of Impacts

The overall risk rating for large bent-winged bat is high, based on a high likelihood and moderate consequence of collisions (**Table 4.18**). The rationale for responses to each criterion is as follows:

a) Based on available data large bent-winged bats are likely to occasionally fly at RSA height in the Project Area.

b) The number of large bent-winged bat records in 2011-2013 and in 2019, indicate that this species either occasionally or regularly occurs in the Project Area. Criterion B is conservatively assigned 'high' here.

c) Large bent-winged bats congregate in large numbers at a few caves in the region the nearest being a maternity cave located at Wee Jasper approximately 45 kilometres south-west of the Project Area. There was no spike in activity of confirmed or potential large bent-winged bat calls during the migration period in autumn 2019. Hence, Criterion C is assigned 'moderate'.

d) The life-history characteristics of the large bent-winged bat overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D.

e) It is likely that the total population of large bent-winged bats is over 20,000 individuals (Churchill 1998, Pennay *et al.* 2011).

f) The large bent-winged bat is listed as vulnerable in NSW under the BC Act.

Table 4.18 Large bent-winged bat risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low					X	
Moderate	X		X	X		X
High	X	X				
Risk Rating						
Likelihood	High	**Consequence**	Moderate	**Risk Rating**	High	

4.3.12 Yellow-bellied sheathtail bat

4.3.12.1 Information on yellow-bellied sheathtail bat from Australian wind farms

There are no published records of blade strike of yellow-bellied sheathtail bats in the available literature from post-construction monitoring conducted in its range in south-eastern Australia (BCD unpublished data, Moloney *et al.* 2019).

4.3.12.2 Status and flight behaviour in the Project Area

The yellow-bellied sheathtail bat was recorded in the Project Area during both the 2011-2013 and 2018/2019 survey events.

Calls for yellow-bellied sheathtail bats were recorded during the 2018/19 surveys, with 14 calls recorded from five locations (**Figure 4.3**). Seven calls were detected from ground level in wooded habitat approximately 1.3 km north of proposed turbine #145. One call from ground level and two calls at 45 m AGL were also recorded at proposed turbine #31. Single calls were recorded from ground level and at 45 m AGL near proposed turbine #80. Single calls were also recorded from ground level near proposed turbine #69 and from ground level near proposed turbine #2.

During the 2011-2013 survey, four yellow-bellied sheathtail bat calls were recorded at one location near proposed turbine #80. NGH (2014) considered this species to be an occasional seasonal visitor in the Project Area.

4.3.12.3 Likelihood and Consequence of Impacts

The overall risk rating for yellow-bellied sheathtail bat is moderate, based on a moderate likelihood and moderate consequence of collisions (**Table 4.19**). The rationale for responses to each criterion is as follows:

a) The yellow-bellied sheathtail bat is likely to regularly fly below RSA height and occasionally fly at RSA height.

b) The yellow-bellied sheathtail bat is likely to occasionally occur in or move through the Project Area. NGH (2014) considered this species to be an occasional seasonal visitor in the Project Area. The data collected during the 2018/19 survey support this.

c) The yellow-bellied sheathtail bat is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the yellow-bellied sheathtail bat overlap with certain aspects of both the descriptions for a ‘low’ and ‘high’ rating for Criterion D.

e) Very little is known about the ecology of the yellow-bellied sheathtail bat though given its very large distribution (Churchill 2008) its population is likely to exceed 5,000 individuals and may possibly be over 20,000. Given the migratory nature of individuals that occur in south-eastern Australia coupled with the lack of any population estimates Criterion E is conservatively assigned ‘moderate’.

f) The yellow-bellied sheathtail bat is listed as vulnerable in NSW under the BC Act.

Table 4.19 Yellow-bellied sheathtail bat risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X			
Moderate	X	X		X	X	X
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	Moderate	

4.3.13 Southern myotis

4.3.13.1 Information on southern myotis from Australian wind farms

There are no records of blade strike of southern myotis in the available literature from post-construction monitoring conducted in its range in south-eastern Australia (BCD unpublished data, Moloney *et al.* 2019).

4.3.13.2 Status and flight behaviour in the Project Area

One southern myotis call was recorded in the Project Area during the 2018/19 bat surveys from ground level near proposed turbine #18 on 12 November 2018. NGH (2014) considered the likelihood of occurrence of this species in the Project Area unlikely.

4.3.13.3 Likelihood and Consequence of Impacts

The overall risk rating for southern myotis is minor, based on a low likelihood and moderate consequence of collisions (**Table 4.20**). The rationale for responses to each criterion is as follows:

a) The southern myotis is likely to rarely fly at RSA height.

b) The southern myotis is likely to rarely occur in the Project Area due to the Project Area’s location relative to this species’ known range in the region coupled with the vegetation present and the number of records from bat surveys conducted in the Project Area to date.

c) The southern myotis is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the southern myotis overlap with certain aspects of both the descriptions for a ‘low’ and ‘high’ rating for Criterion D.

e) The southern myotis has a large distribution in northern and eastern Australia where it is generally uncommon (Churchill 2008). Given the lack of any population estimates Criterion E is conservatively assigned 'moderate'.

f) The southern myotis is listed as vulnerable in NSW under the BC Act.

Table 4.20 Southern myotis risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X	X	X			
Moderate				X	X	X
High						
Risk Rating						
Likelihood	Low	**Consequence**	Moderate	**Risk Rating**	Minor	

4.3.14 Eastern false pipistrelle

4.3.14.1 Information on eastern false pipistrelle from Australian wind farms

There are 28 records of dead eastern false pipistrelles found at Victorian wind farms during post-construction mortality monitoring from 2003 to 2018 (Moloney *et al.* 2019). Moloney *et al.* 2019 calculated mortality estimates of 1.6 (95% CI: 0.6 – 2.9) individuals per turbine per year at one wind farm.

4.3.14.2 Status and flight behaviour in the Project Area

The eastern false pipistrelle was recorded once in the Project Area during the 2018/19 bat surveys, from ground level near proposed turbine #69 (**Figure 4.3**). Four eastern false pipistrelle calls have previously been recorded at one location near proposed turbine #80 (NGH 2014). This relatively low number of detections is probably a result of the Project Area's location corresponding to the western edge of the eastern false pipistrelle's known range in the region.

4.3.14.3 Likelihood and Consequence of Impacts

The overall risk rating for eastern false pipistrelles is moderate, based on a moderate likelihood and moderate consequence of collisions (**Table 4.21**). The rationale for responses to each criterion is as follows:

a) The eastern false pipistrelle likely regularly flies below RSA height and occasionally flies at RSA height.

b) The eastern false pipistrelle is considered to rarely or occasionally occur in the Project Area due to the Project Area's location relative to this species' known range in the region coupled with the vegetation present in the Project Area and the low number of records from bat surveys conducted in the Project Area to date.

c) The eastern false pipistrelle is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

d) The life-history characteristics of the eastern false pipistrelle overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D

e) Given the lack of any population estimates for eastern false pipistrelles Criterion E is conservatively assigned 'moderate'.

f) The eastern false pipistrelle is listed as vulnerable in NSW under the BC Act.

Table 4.21 Eastern false pipistrelle risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X			
Moderate	X	X		X	X	X
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	Moderate	

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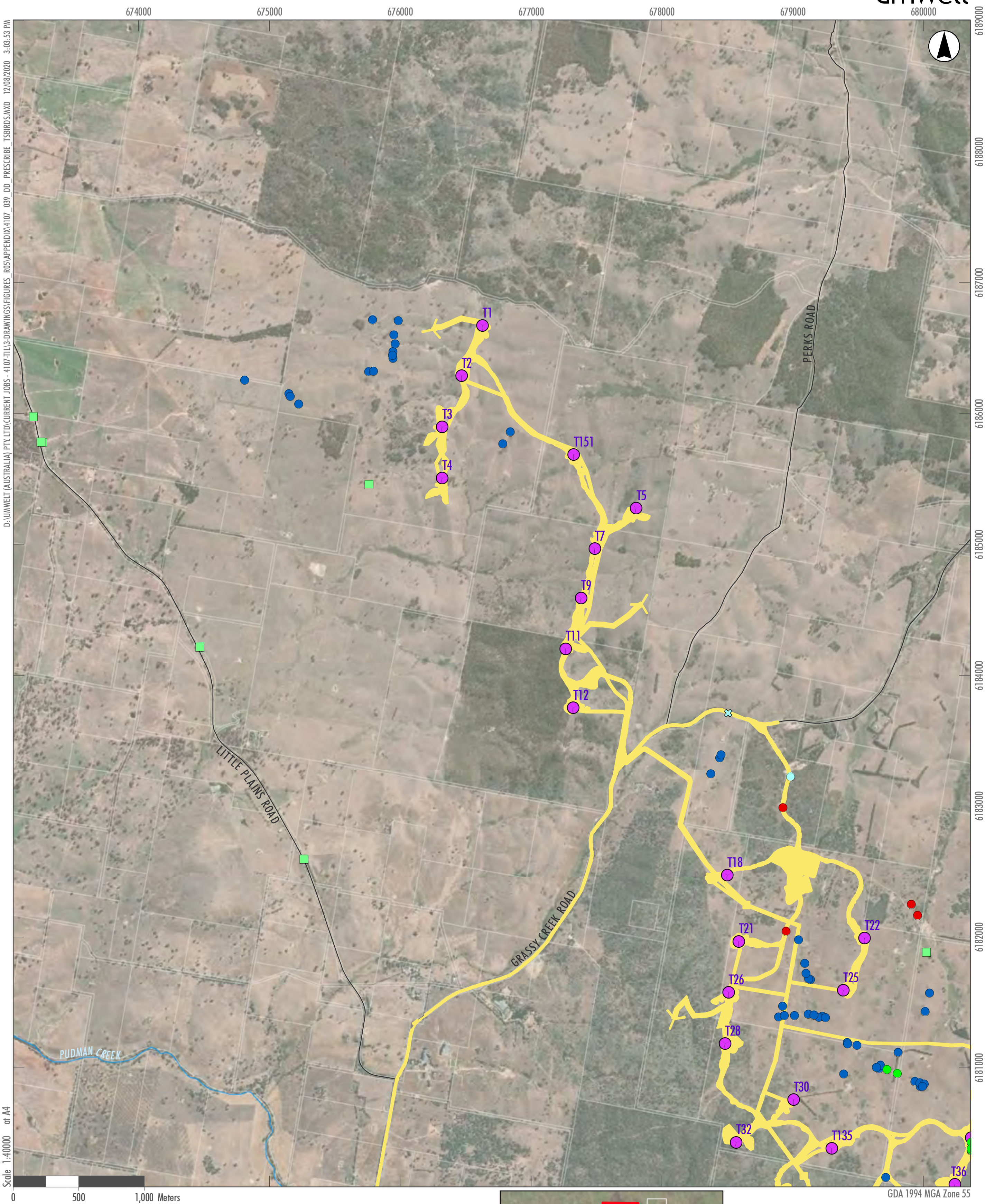

Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

EPBC Act Species

- White-throated Needletail

NSW BC Act and EPBC Act Species

- Superb Parrot

NSW BC Act Species

- Dusky Woodswallow
- Varied Sittella
- Black Falcon
- Little Eagle
- Hooded Robin
- Scarlet Robin
- Flame Robin
- Speckled Warbler
- White-fronted Chat

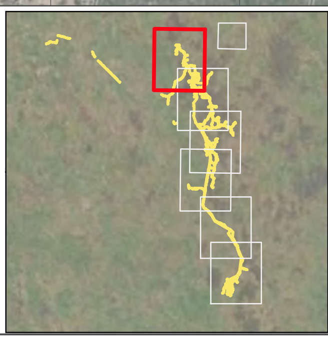

FIGURE 4.1.1

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

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Scale 1:20000 at A4

0 500 1,000 Meters

GDA 1994 MGA Zone 55

Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

NSW BC Act and EPBC Act Species

- Superb Parrot

NSW BC Act Species

- Dusky Woodswallow
- Varied Sittella
- Black Falcon
- Little Eagle
- Hooded Robin
- Scarlet Robin
- Flame Robin
- Speckled Warbler
- White-fronted Chat

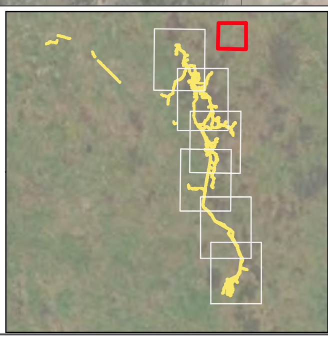


FIGURE 4.1.2

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

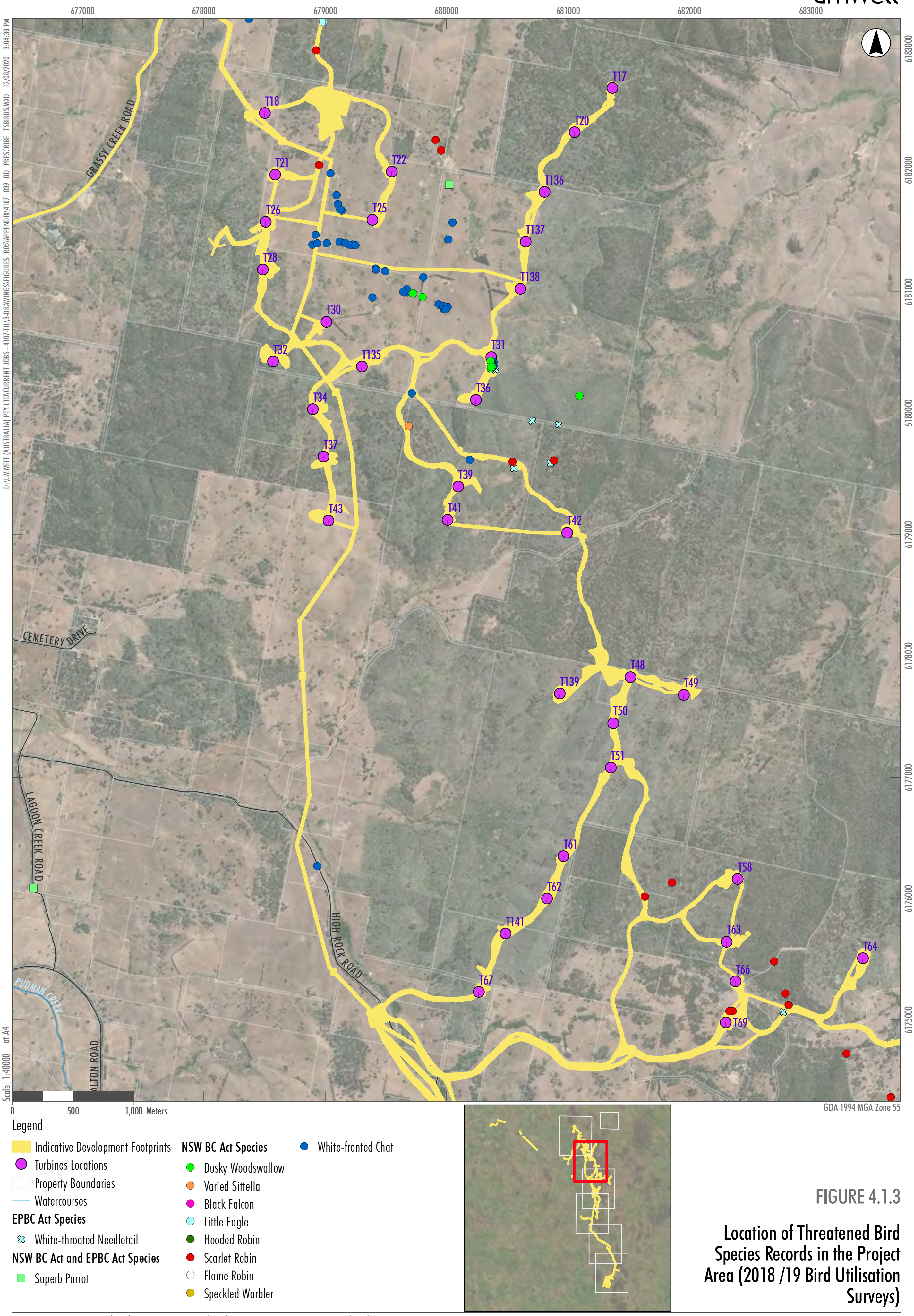


FIGURE 4.1.3

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

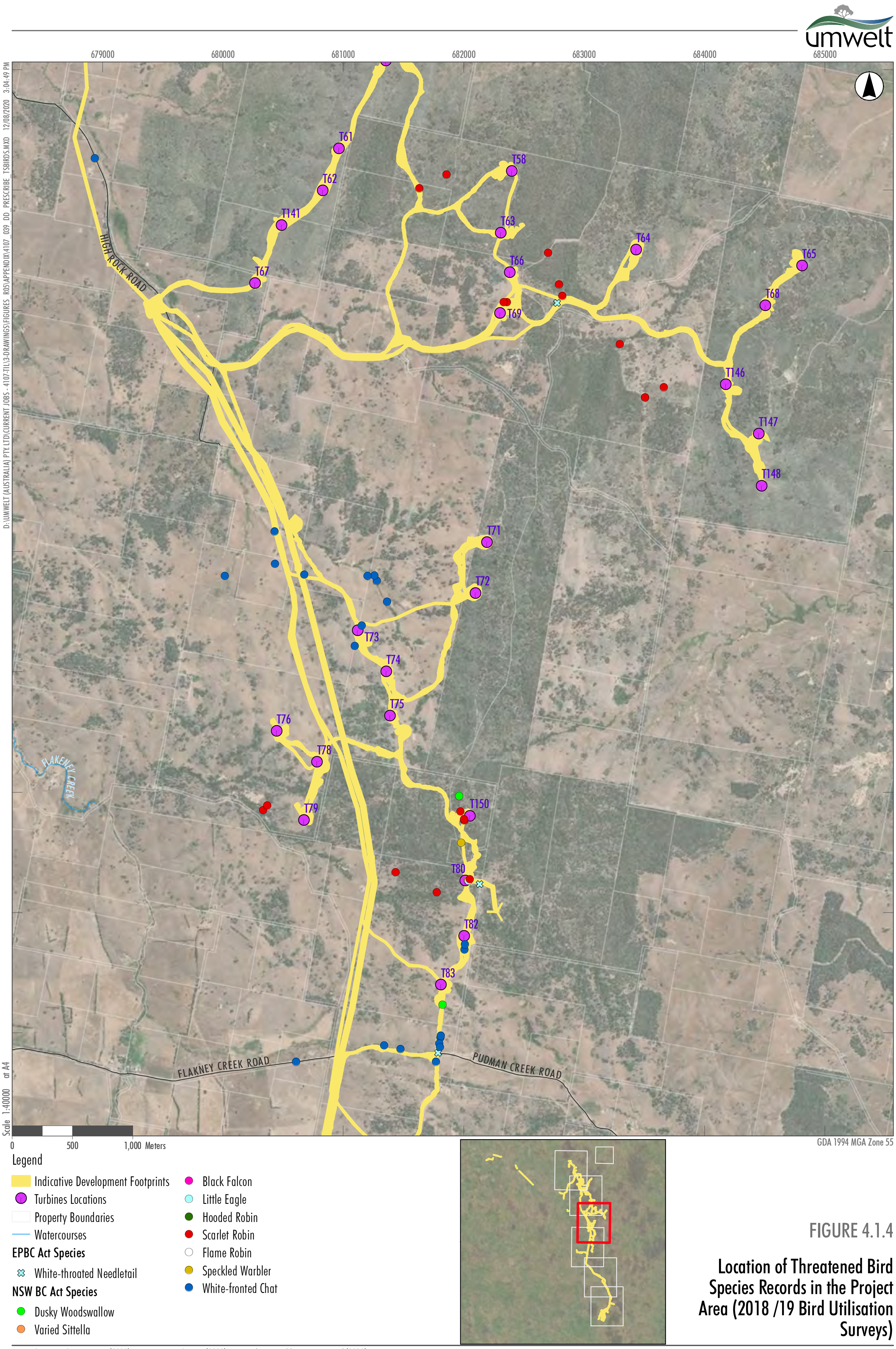


FIGURE 4.1.4

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

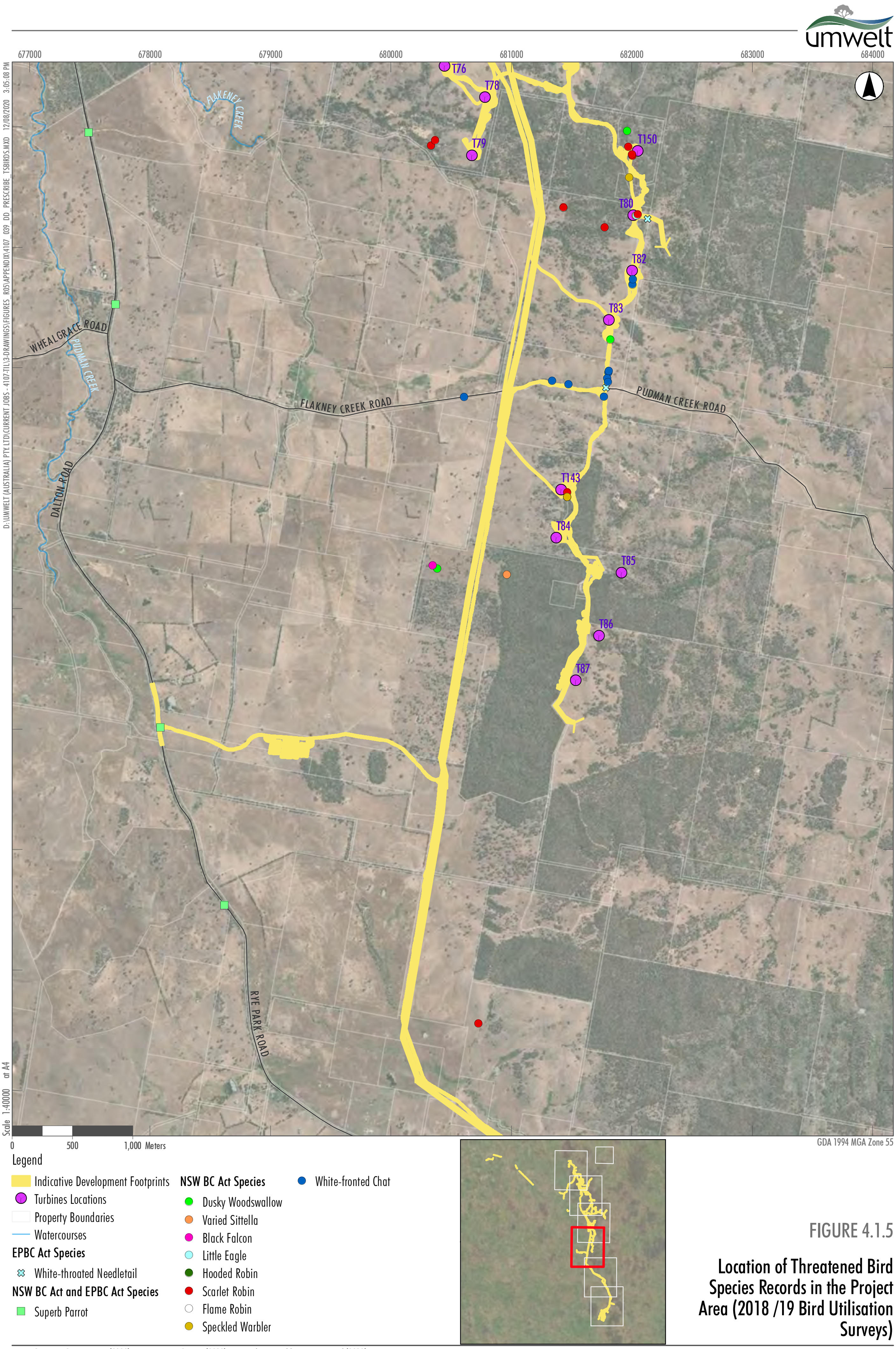
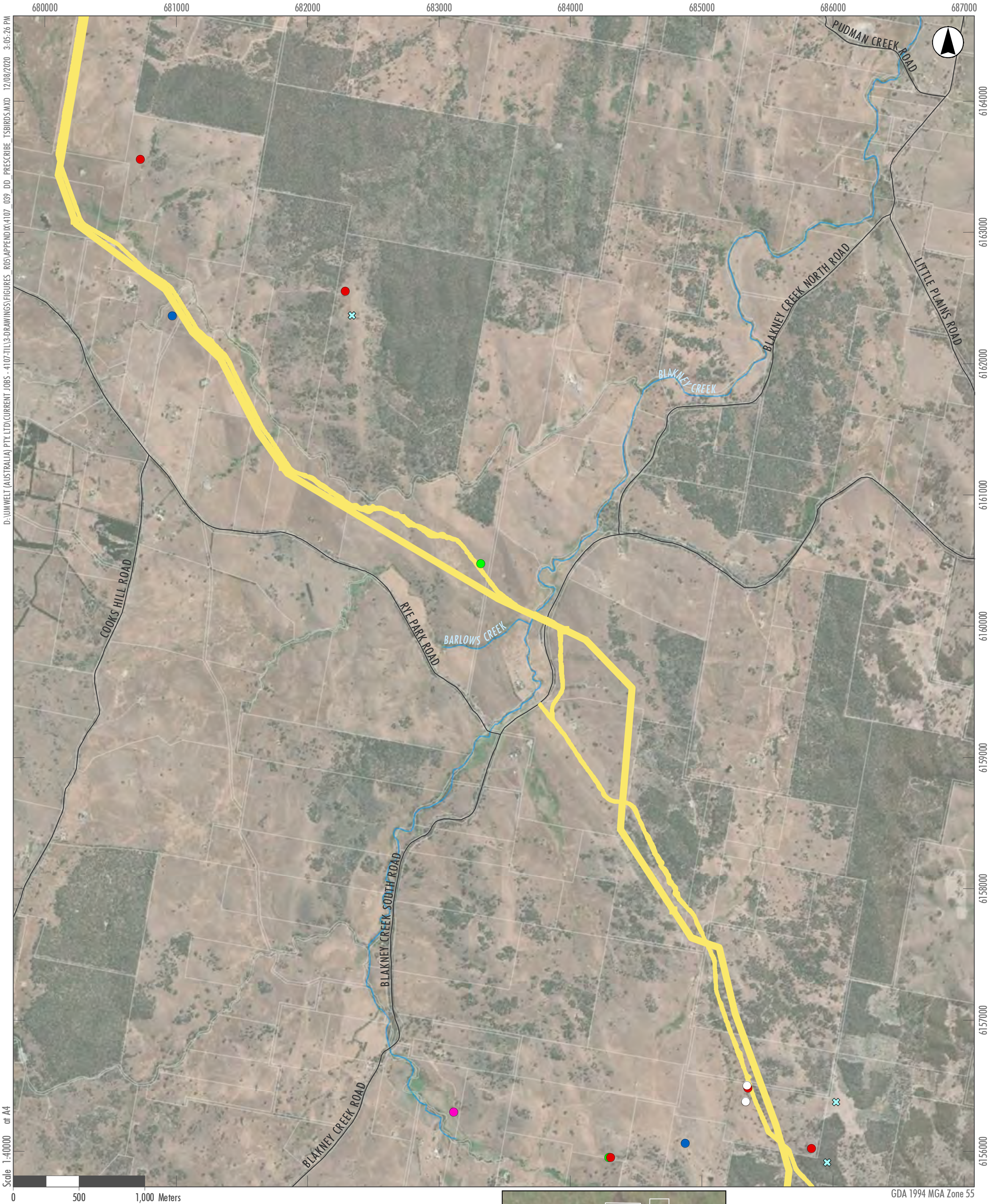


FIGURE 4.1.5

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

EPBC Act Species

- White-throated Needletail

NSW BC Act Species

- Dusky Woodswallow
- Varied Sittella
- Black Falcon
- Little Eagle
- Hooded Robin
- Scarlet Robin
- Flame Robin
- Speckled Warbler
- White-fronted Chat

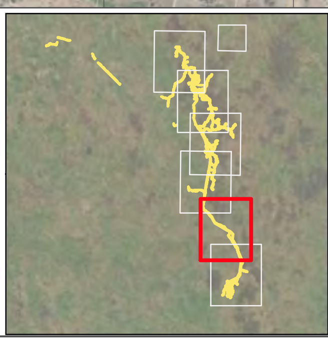


FIGURE 4.1.6

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

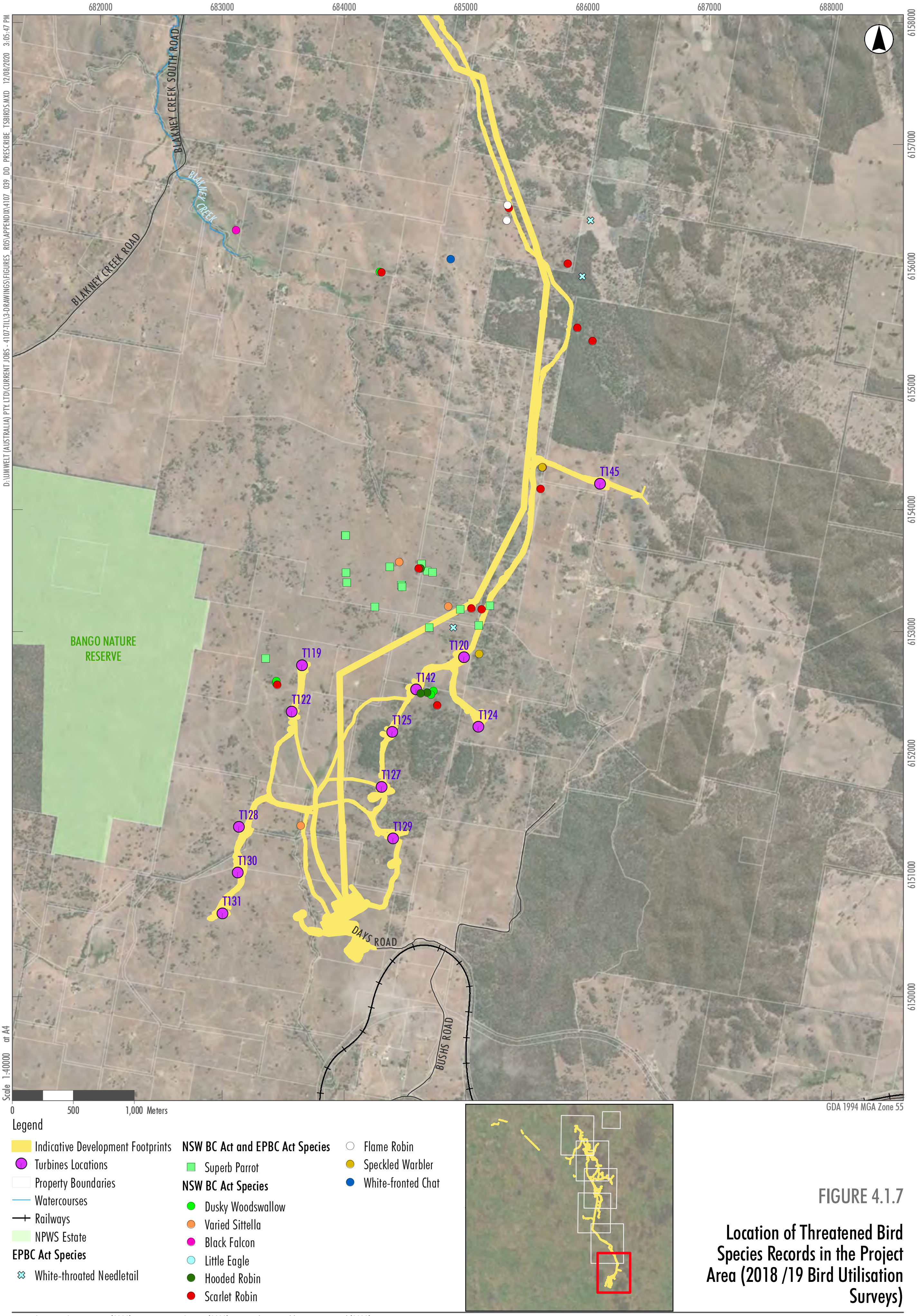
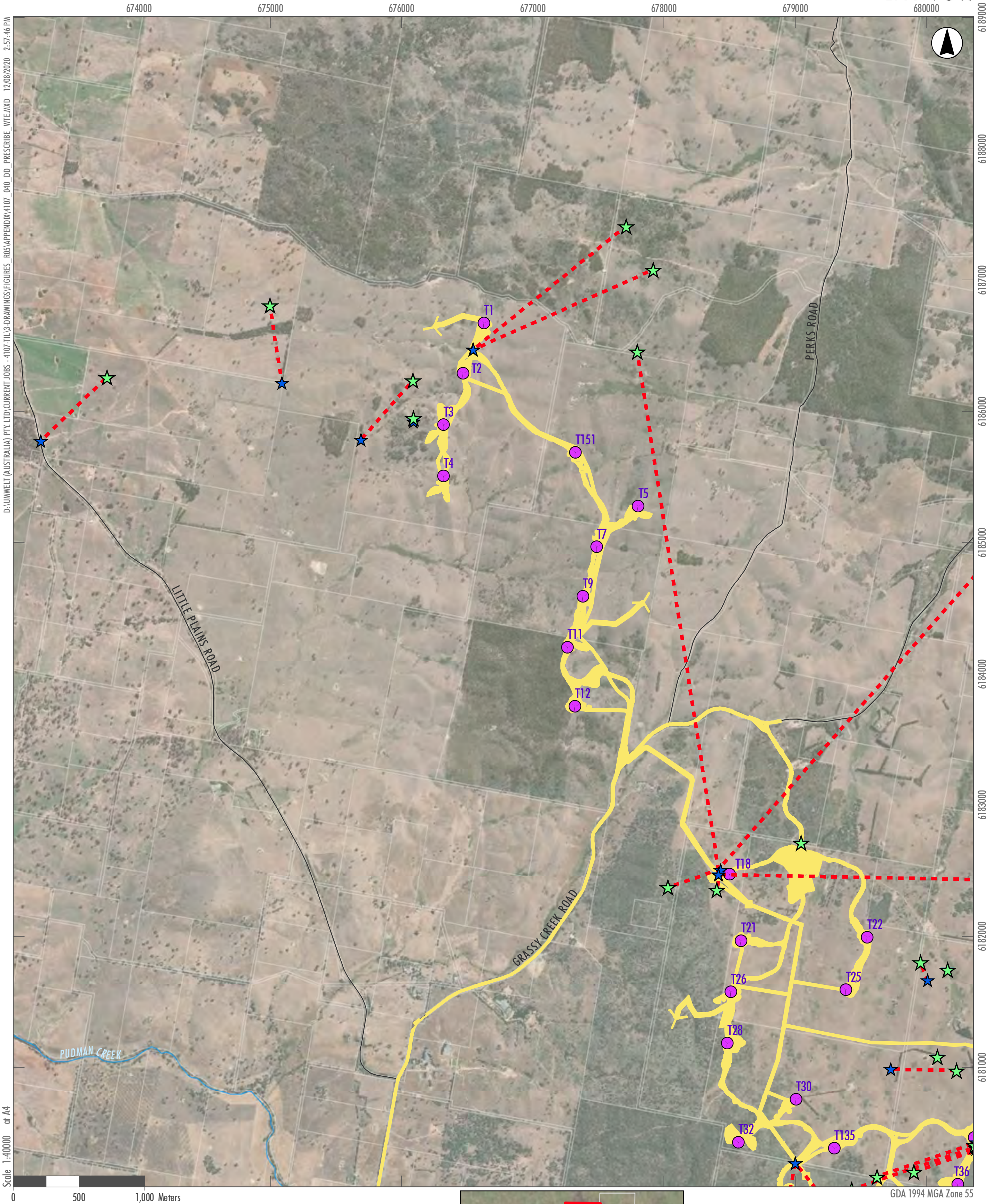


FIGURE 4.1.7

Location of Threatened Bird Species Records in the Project Area (2018 /19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



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Legend
- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

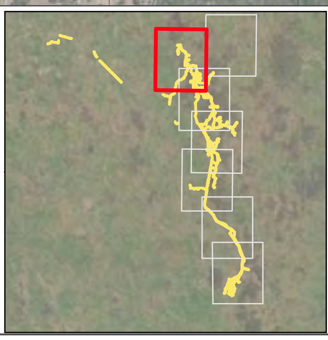

FIGURE 4.2.1

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

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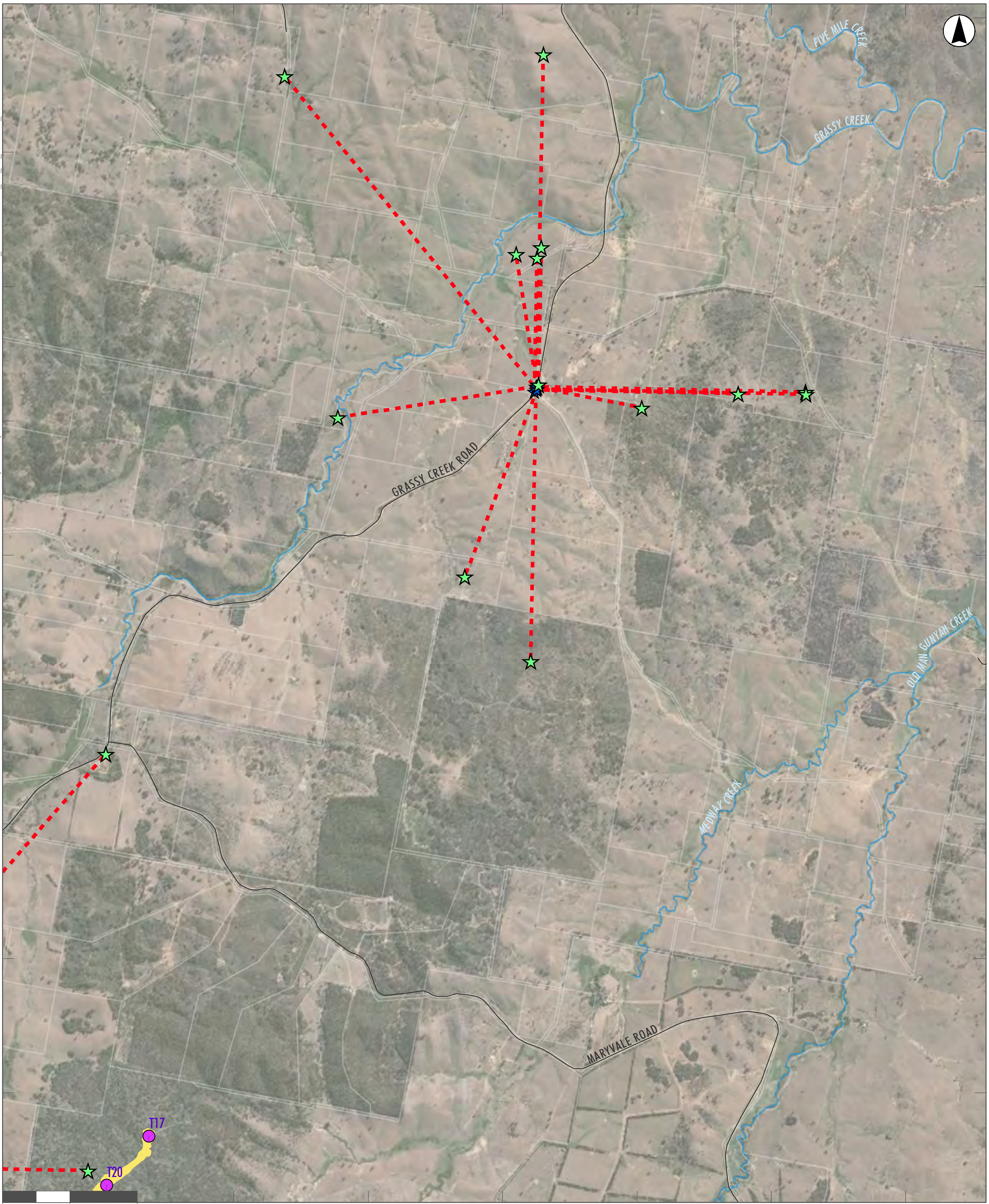

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Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

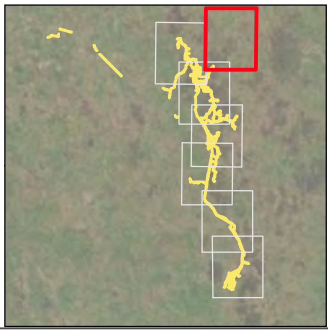
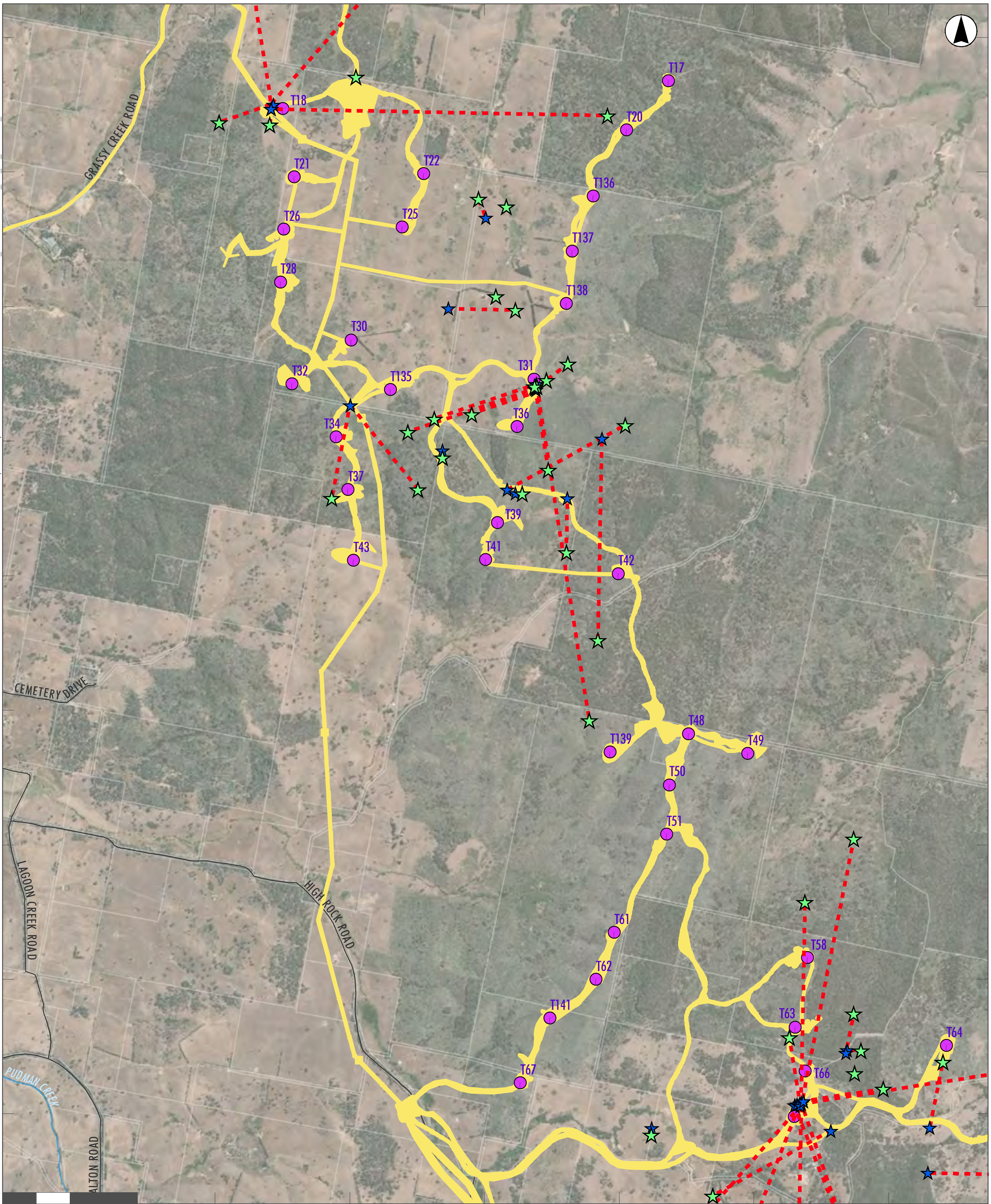


FIGURE 4.2.2

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

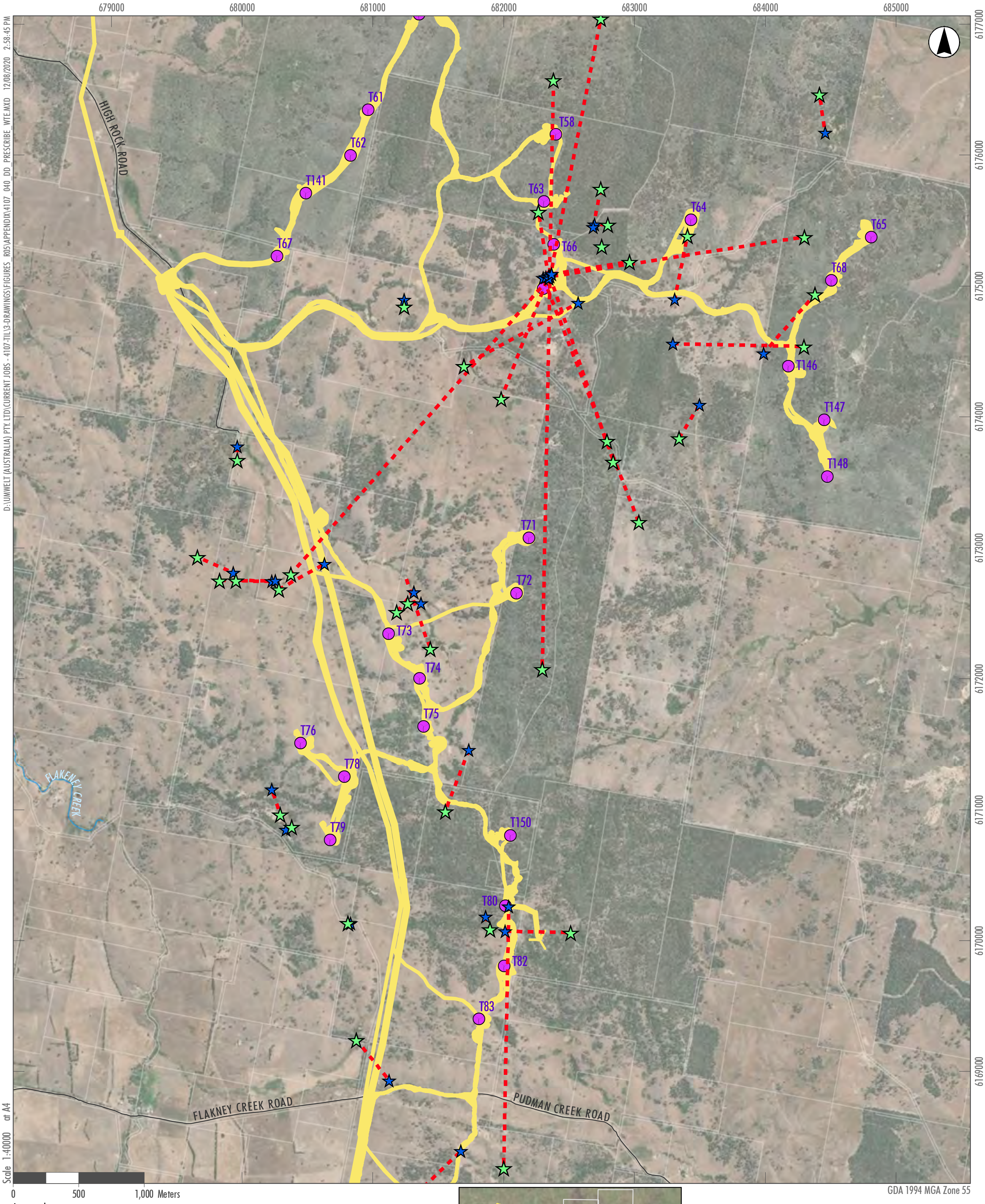


Legend
- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

FIGURE 4.2.3

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



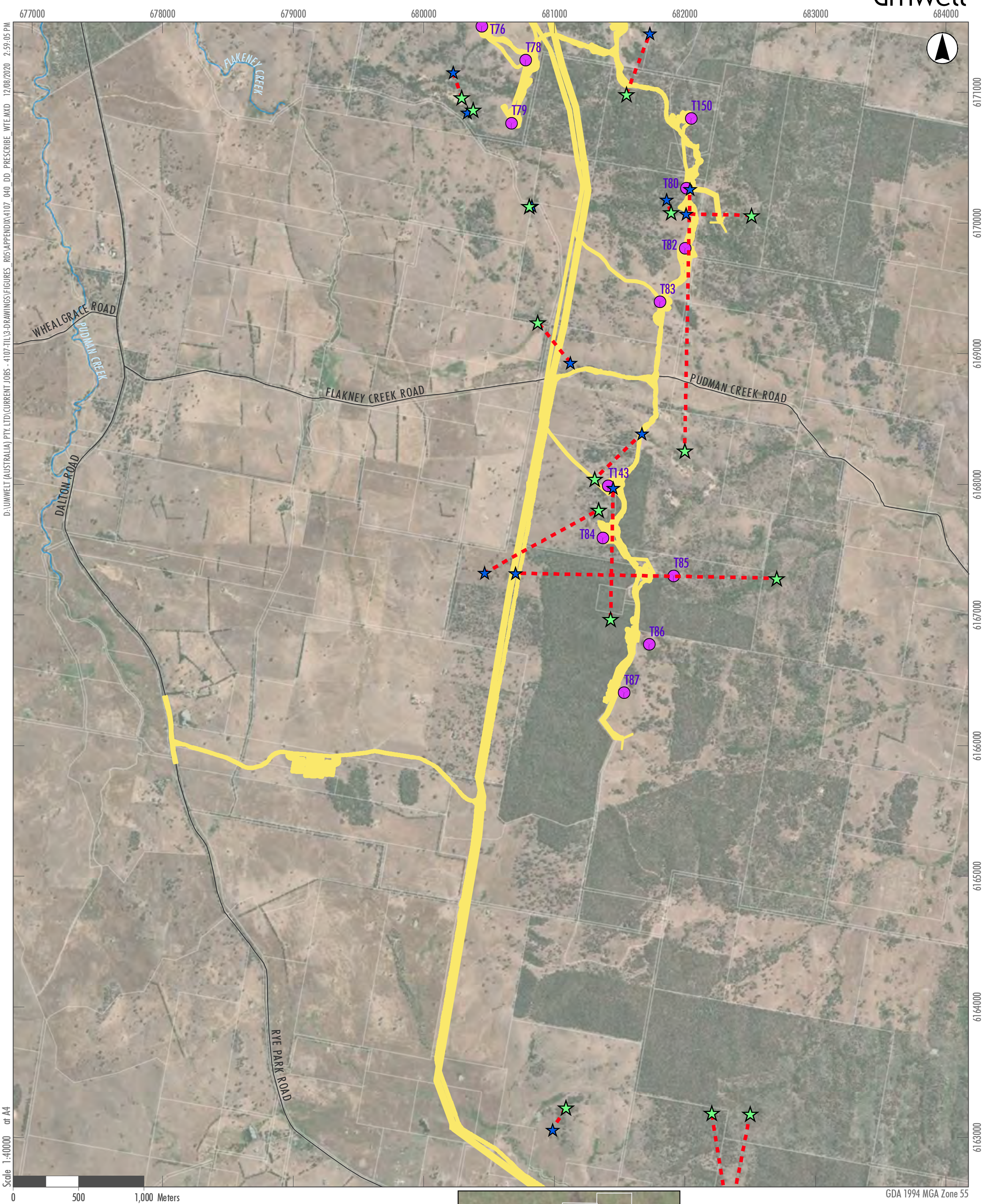
Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

FIGURE 4.2.4

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

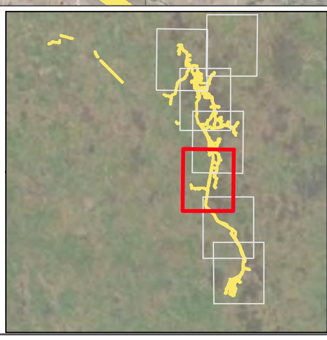
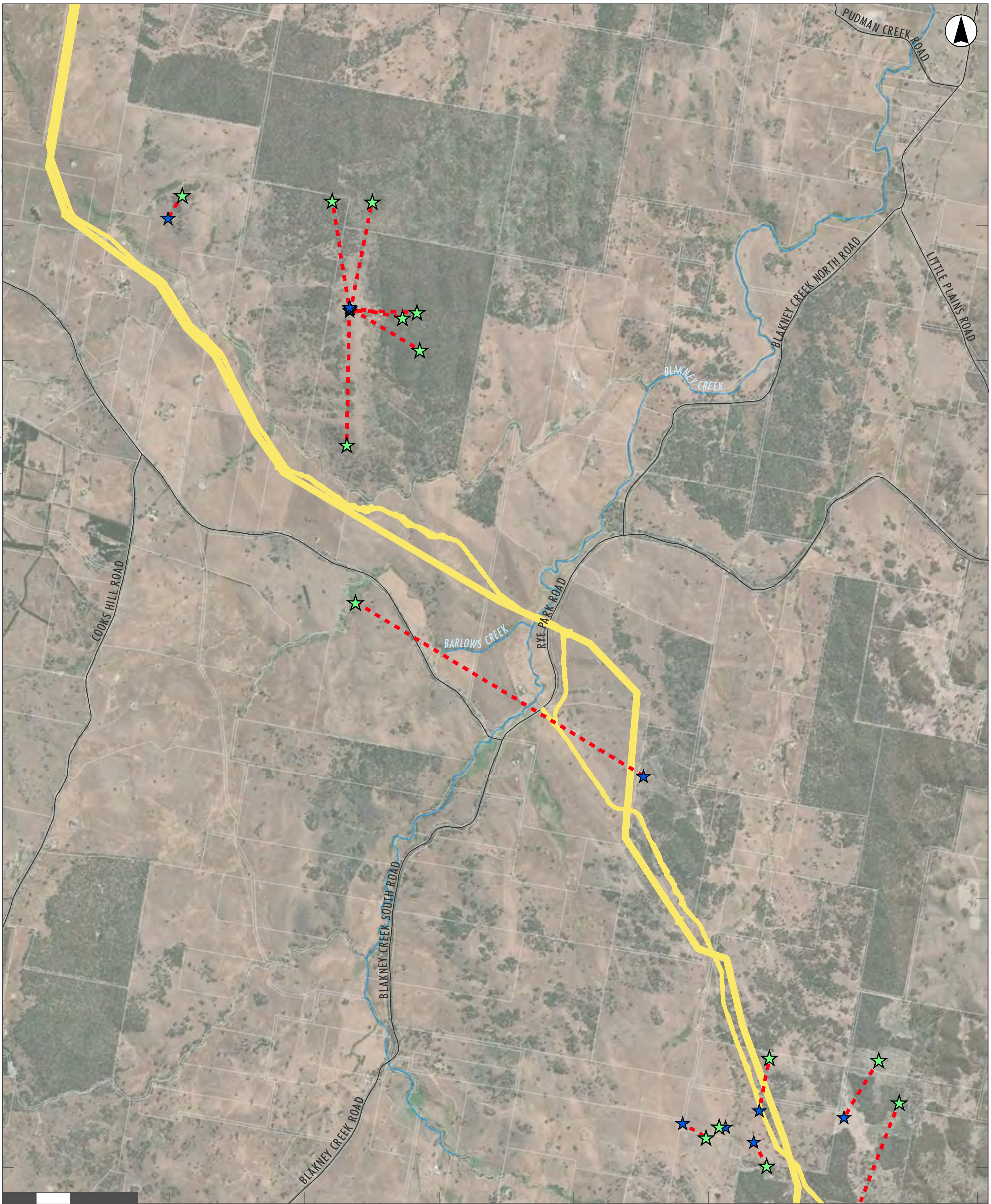


FIGURE 4.2.5

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



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Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

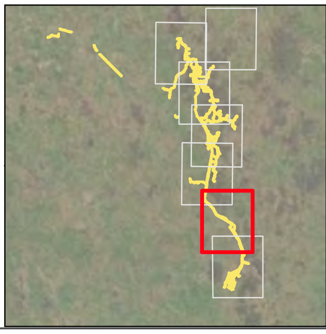
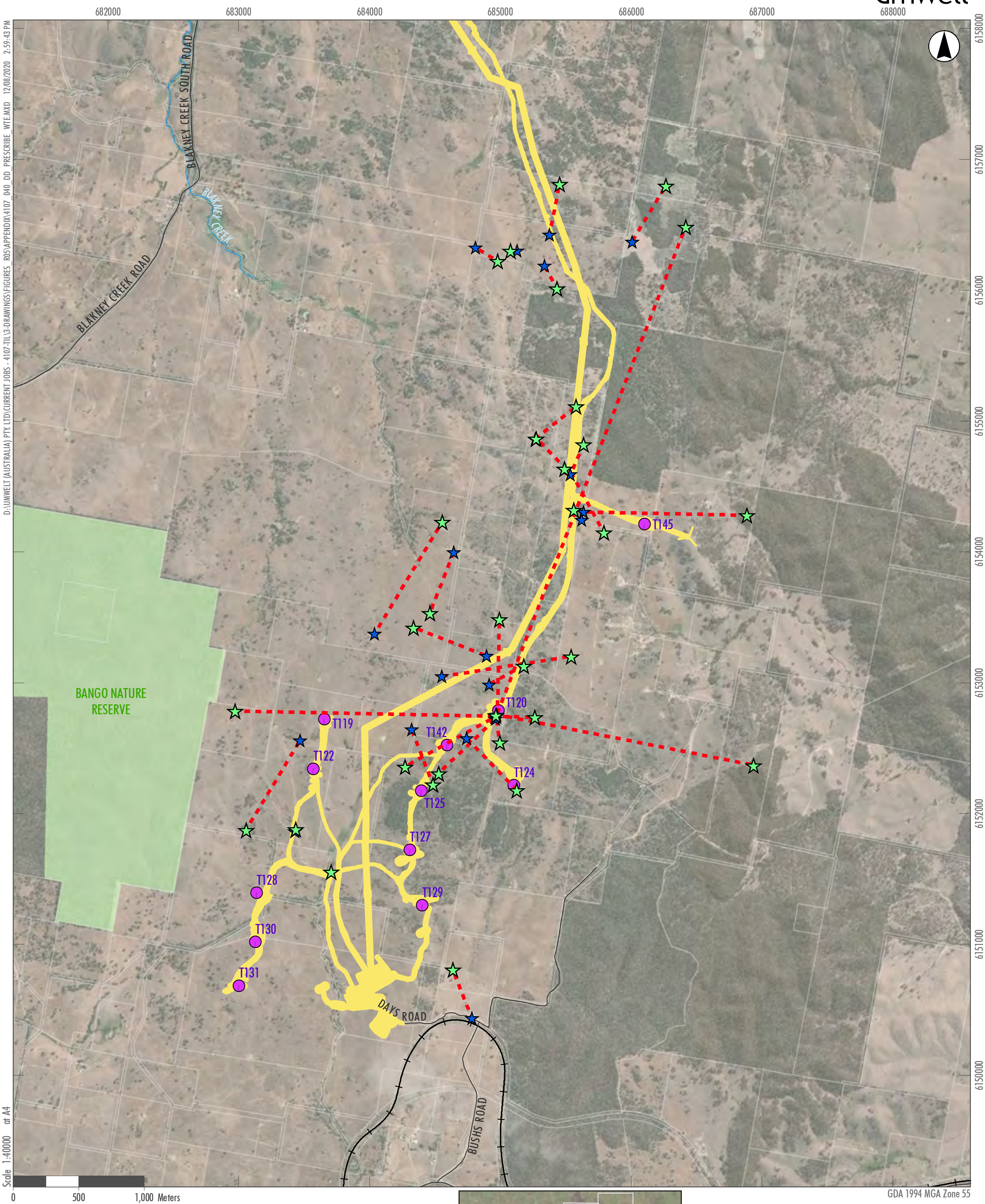


FIGURE 4.2.6

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



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Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Railways
- NPWS Estate
- Observer Location
- Observer Direction and Distance of Wedge-Tailed Eagle Sighting
- Wedge-Tailed Eagle Location

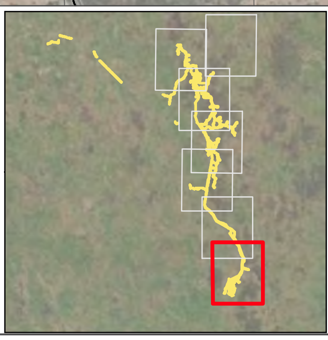


FIGURE 4.2.7

Location of Wedge-Tailed Eagles Records in the Project Area (2018 / 19 Bird Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

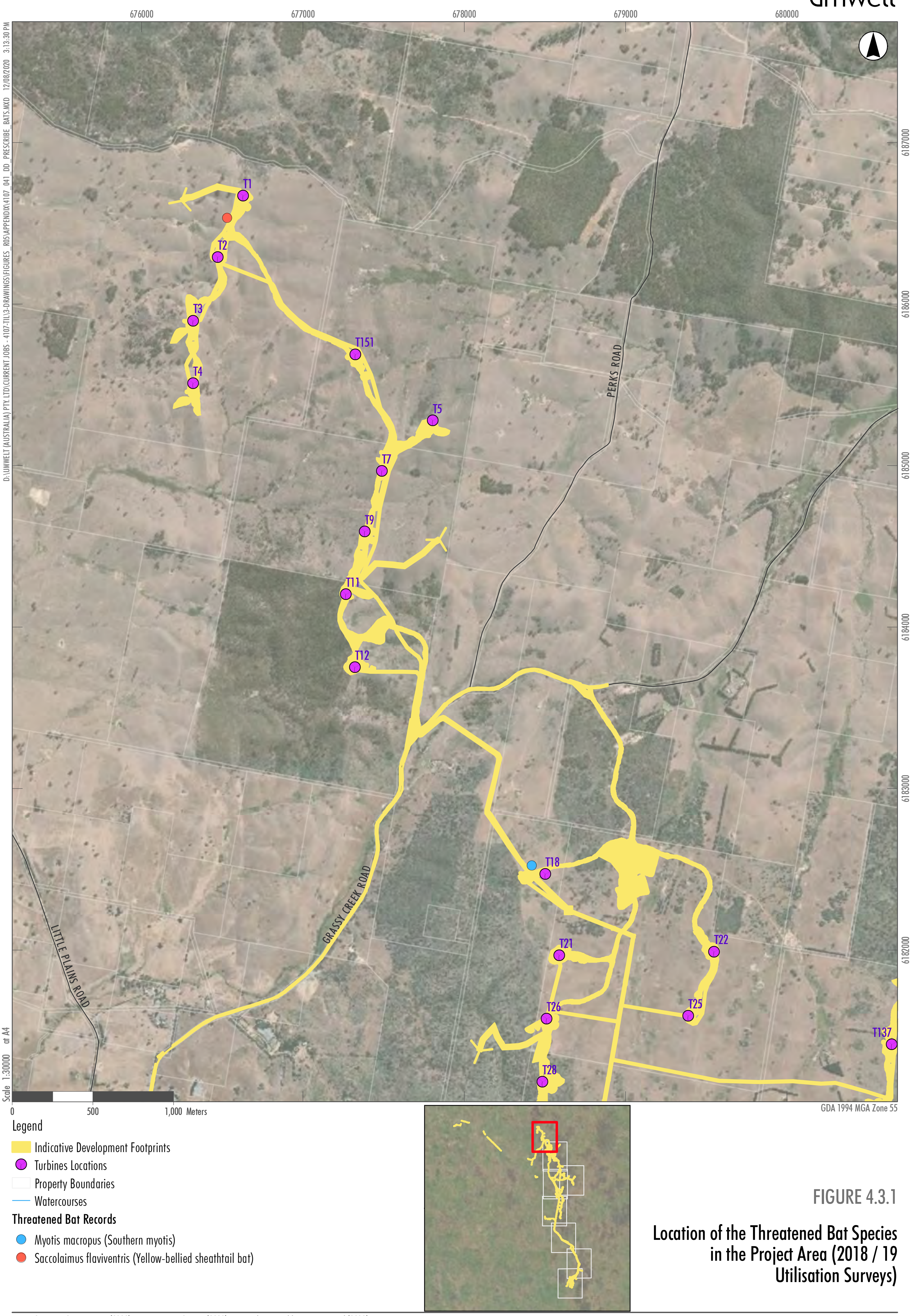
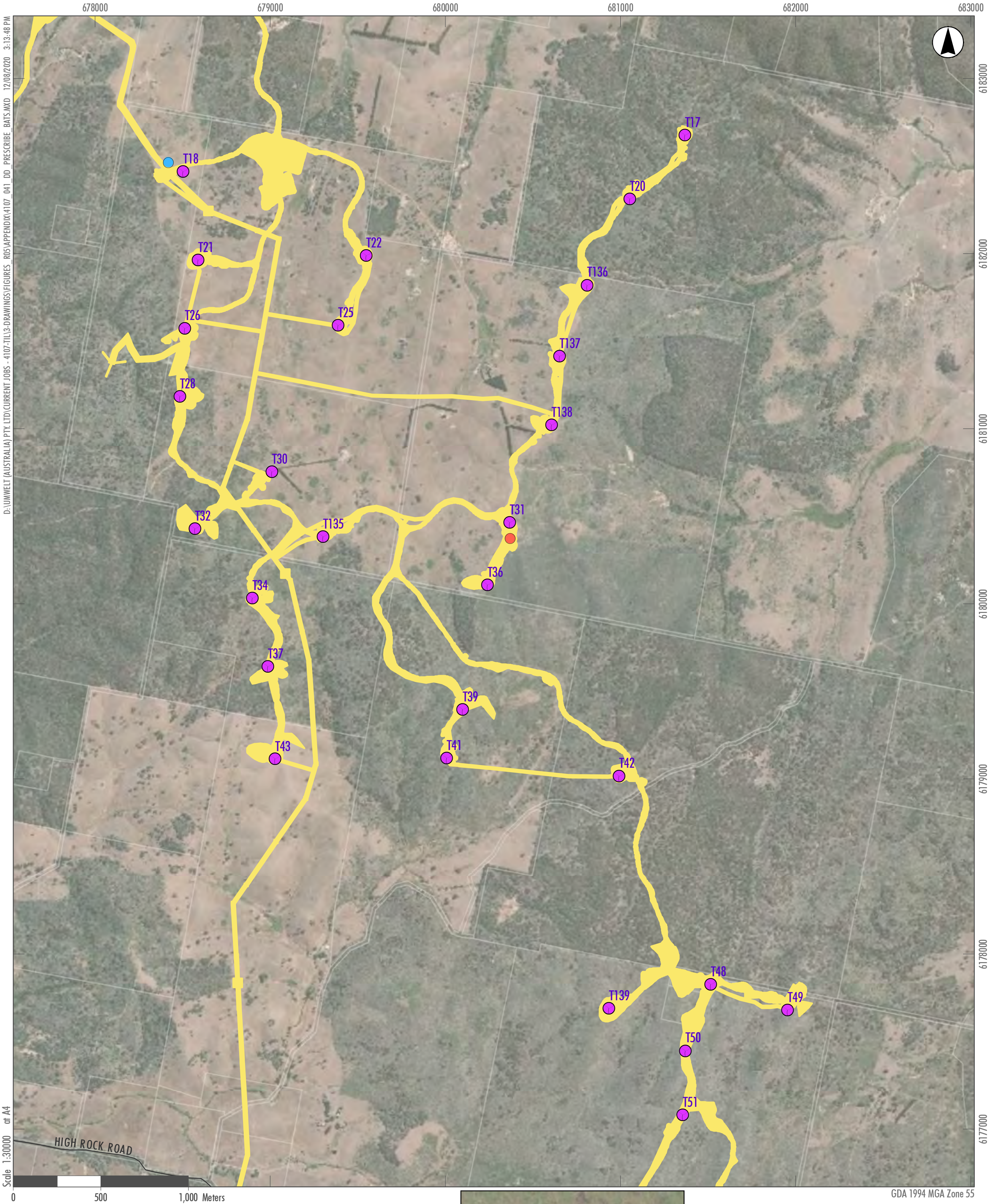


FIGURE 4.3.1

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



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Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

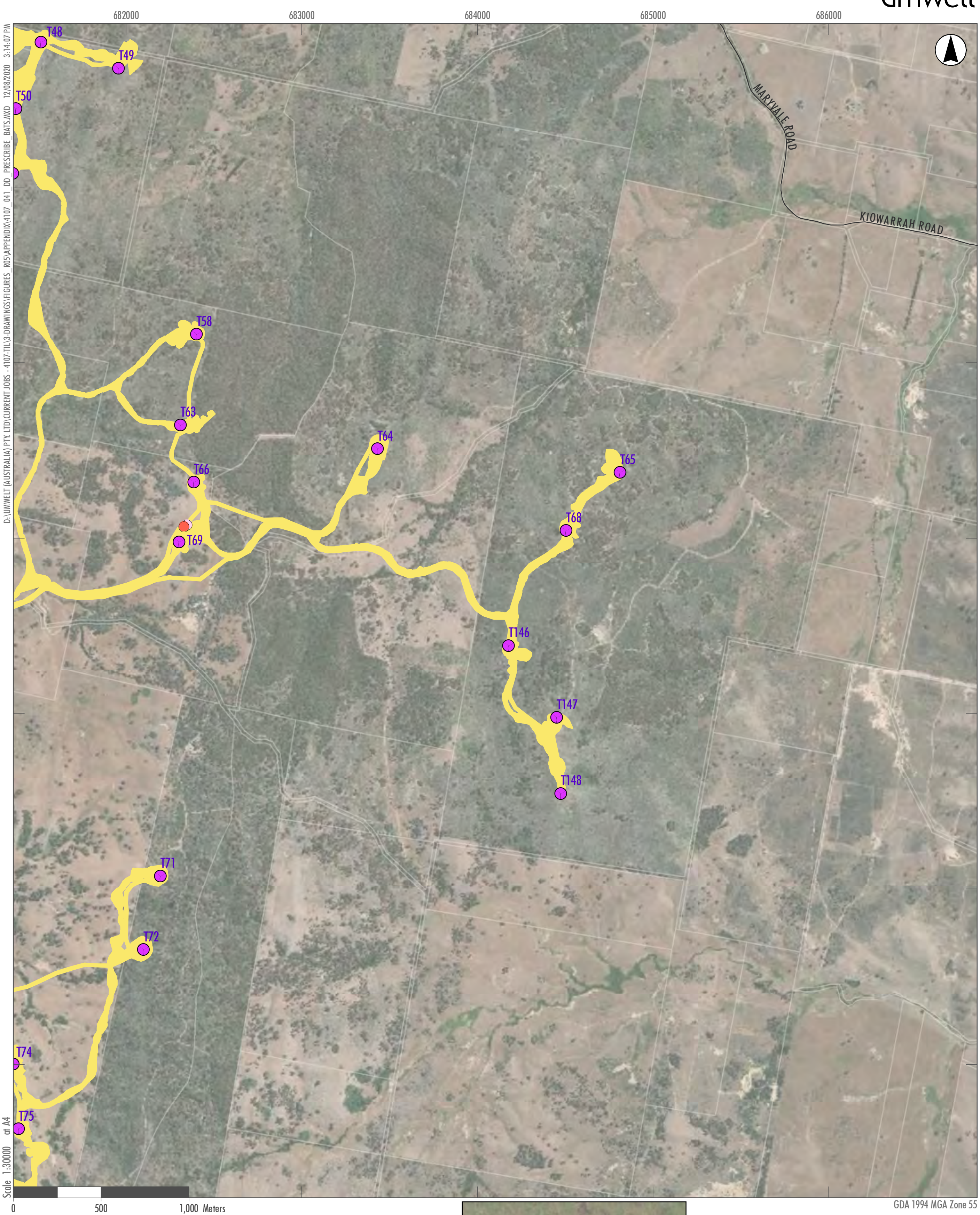
Threatened Bat Records

- Myotis macropus (Southern myotis)
- Saccolaimus flaviventris (Yellow-bellied sheathtail bat)

FIGURE 4.3.2

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

Threatened Bat Records

- *Falsistrellus tasmaniensis* (Eastern false pipistelle)
- *Saccolaimus flaviventris* (Yellow-bellied sheathtail bat)

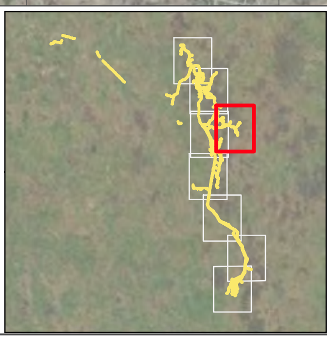


FIGURE 4.3.3

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

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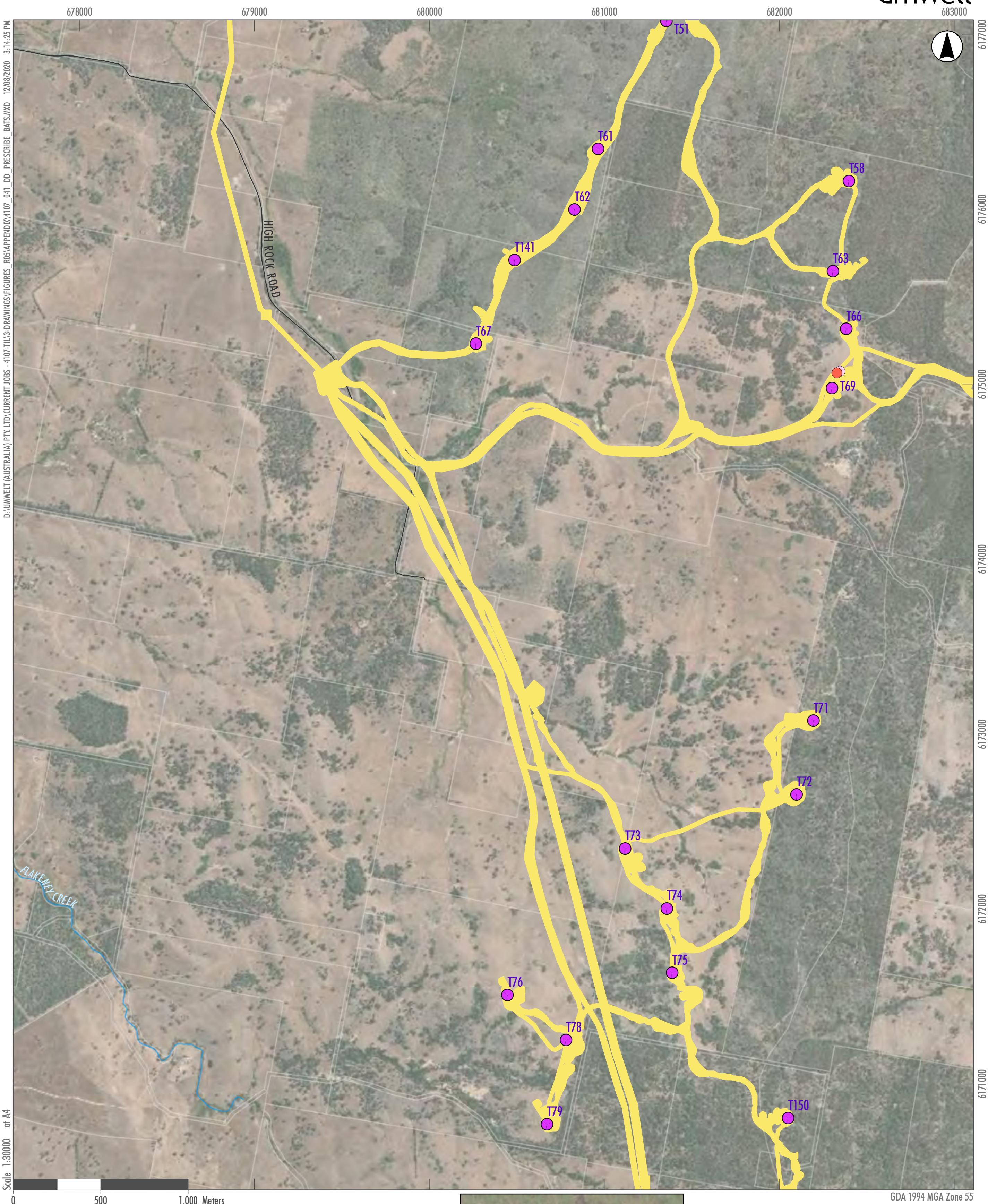


Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

Threatened Bat Records

- *Falsistrellus tasmaniensis* (Eastern false pipistelle)
- *Saccolaimus flaviventris* (Yellow-bellied sheathtail bat)

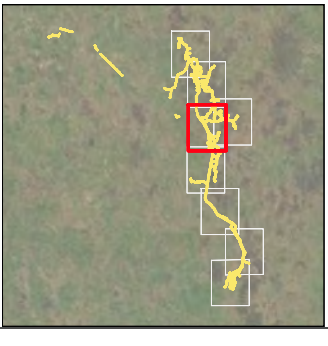
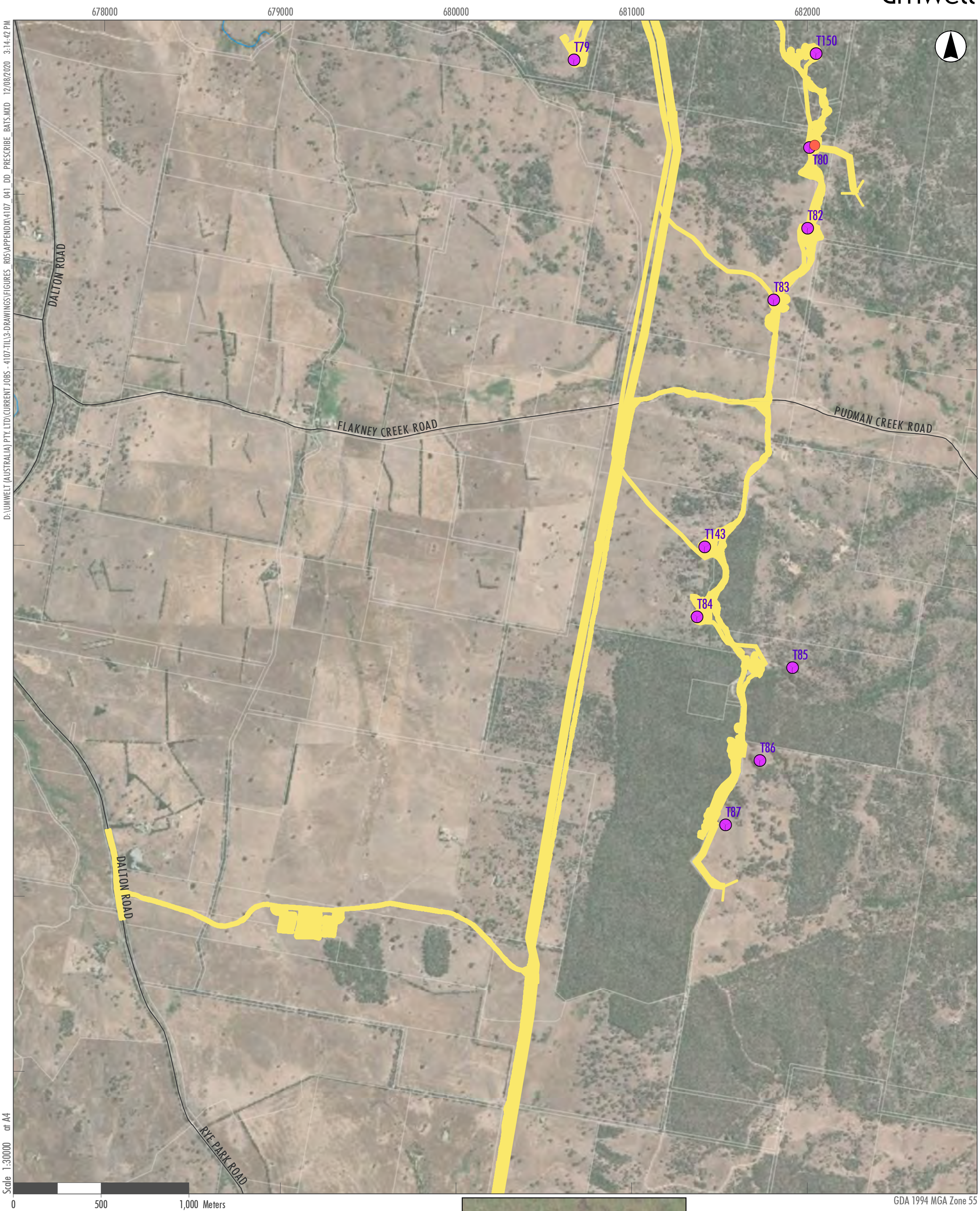


FIGURE 4.3.4

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)



Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

Threatened Bat Records

- *Saccolaimus flaviventris* (Yellow-bellied sheathtail bat)

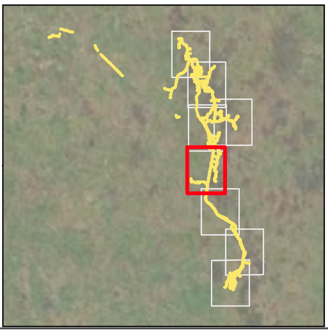


FIGURE 4.3.5

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

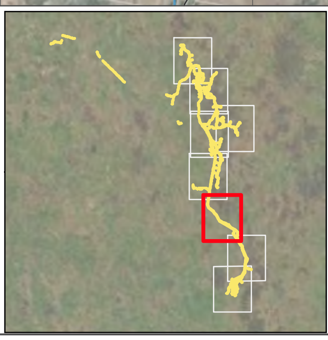


FIGURE 4.3.6

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses

Threatened Bat Records

- Saccolaimus flaviventris (Yellow-bellied sheathtail bat)

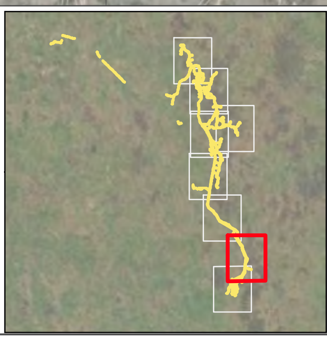
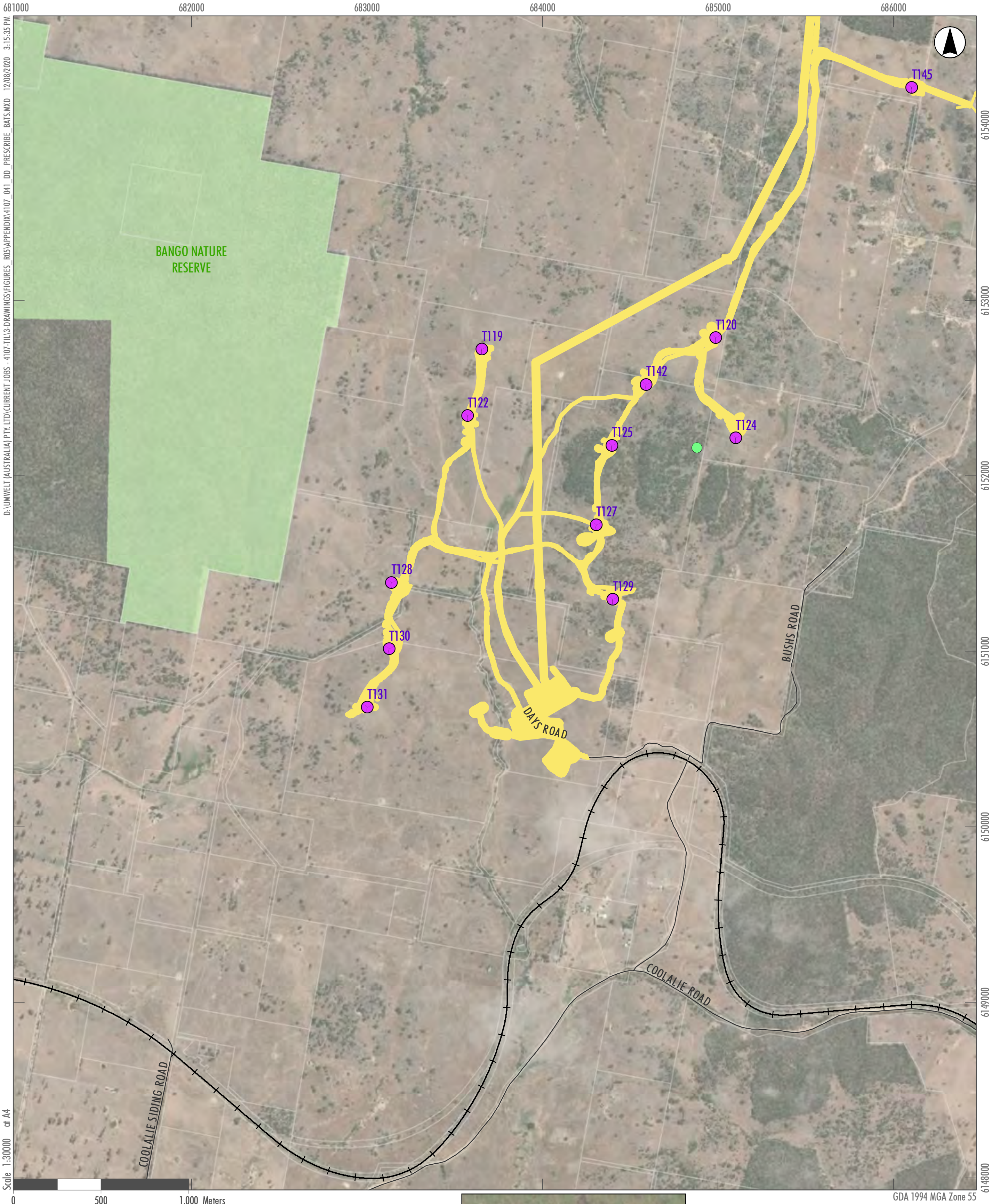


FIGURE 4.3.7

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

umwelt



Legend

- Indicative Development Footprints
- Turbines Locations
- Property Boundaries
- Watercourses
- Railways
- NPWS Estate

Threatened Bat Records

- *Miniopterus orianae oceanensis* (Large bent-winged bat)

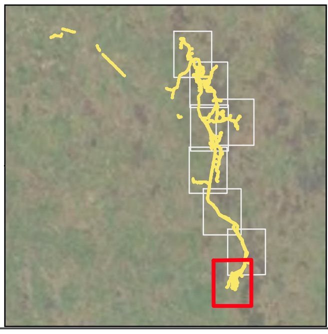


FIGURE 4.3.8

Location of the Threatened Bat Species in the Project Area (2018 / 19 Utilisation Surveys)

Image Source: ESRI Basemap (2020) Data source: NSW LPI (2020); Rye Park Renewable Energy Pty Ltd (2020)

5.0 Predict the consequences of impacts for the persistence of bioregional populations, with reference to relevant literature and other published sources of information

The consequences of impacts for the persistence of the assessed species in the bioregion depends on a range of poorly understood or unknown factors including the following:

- the relative importance of the Project Area for the long-term persistence of the greater population in the bioregion
- the degree of connectivity in regard to the movement of individuals between the Project Area and surrounding areas
- whether likely mortality rates from blade strike in the Project Area would exceed the rate of replacement of individuals either in situ or through dispersal from elsewhere.

Given the lack of data with which to predict estimates and the inherent high uncertainty associated with predictions if attempted, the consequence of impacts for the persistence of bioregional populations is not predicted here.

6.0 Predict the cumulative impacts of the project together with existing wind farms on aerial species mortality and provide justification for these predictions

For the purpose of this section, the following aerial species which have a highly localised population at or near the Project Area are examined:

- Large bent-winged bat
- Superb parrot.

In order to adequately assess cumulative impacts of the Project together with other wind farms in the region, it is first necessary for the effects of all other relevant wind farms to be quantified to a consistent standard and to be available (Moloney et al. 2019). In the absence of this information, a summary including an examination of basic factors such as species distribution relative to nearby wind farms and the total number of turbines in the region is provided below.

The following three operational projects, three projects under construction and one approved project are considered to be in the region (c. 3,000km^2) in which the Project is situated:

- Cullerin Range Wind Farm (operational since 2009), 15 turbines
- Gullen Range Wind Farm (operational since 2013), 73 turbines
- Gunning Wind Farm (operational since 2011), 31 turbines
- Bango Wind Farm (under construction), 46 turbines
- Collector Wind Farm (under construction), 54 turbines
- Biala Wind Farm (under construction), 31 turbines
- Coppabella Wind Farm (approved), 75 turbines.

At present there are a total of 122 operational turbines in the region with a further 131 under construction and 75 approved. Therefore, the installation of 80 turbines approved at Rye Park Wind Farm will result in a 32% increase in the number of turbines in the region (assuming completion of the three wind farms currently under construction). It is noted that the impact of each turbine on the species assessed here would not be equal across the region considering variability in abundance and site occupancy at multiple spatial scales (i.e. landscape scale, within wind farm scale) and variability in turbine specifications would influence the likelihood of collisions.

6.1 Superb parrot

Factors such as the superb parrot's flight behaviour and their movement patterns in the region, coupled with the proportion of their population that occurs in the region highlights the potential for a cumulative impact on this species as a result of the direct and indirect impacts associated with wind farms.

Superb parrots have been recorded at the four wind farms that are approved or under construction in the region and may occur at the three operational wind farms. Due to the location of the three wind farms operational as of July 2020 (Cullerin Wind Farm, Gullen Range Wind Farm and Gunning Wind Farm) on the eastern edge of the superb parrot's range it is likely that the cumulative impact at present is relatively low. However, the introduction of three wind farms in their core range (namely Bango Wind Farm, Coppabella Wind Farm and the Project) has the to result in increase the risk of a cumulative impact in this region once these projects are operational.

The construction of the Project would result in the addition of 80 turbines which corresponds to a 32% increase in the total number of turbines in the region. The degree to which this development will contribute to the overall cumulative impact is unknown however, as discussed in **Section** Error! Reference source not found.**,** certain turbines are likely to pose a greater risk than others. Due to the location of Bango Wind Farm, its position in the landscape and the amount of suitable superb parrot habitat present (ERM 2013), it is considered that that wind farm will pose a greater risk per turbine (and potentially overall) to superb parrot than the Project especially given specific turbines identified by NGH (2014) as posing the highest risk to superb parrots have been removed from the Project's layout.

Research to be conducted on the movement of superb parrots in the Yass region and impact monitoring to be conducted in the Project Area and at the under construction Bango Wind Farm as part of the Superb Parrot Population Monitoring Program is likely to improve our understanding of the susceptibility of this species to blade strike and indirect impacts resulting from the operation of turbines (Rayner 2019). This research may allow an informed cumulative impact assessment to be conducted for this region in the future.

6.2 Large bent-winged bat

Factors such as the large bent-winged bat's flight behaviour, and their movement patterns in the region, coupled the proportion of their population that occurs in the region indicates the potential for a cumulative impact on this species resulting from direct and indirect impacts associated with wind farms.

Large bent-winged bats have been recorded at four wind farms in the region and have potential to occur at the remaining three, for which there is poor availability of ecological survey data. Each of the three operational wind farms, the three under construction wind farms and the two approved wind farms in the region are located within 60 km of known maternity cave sites in the region at Wee Jasper and Bungonia. The movement of large bent-winged bats in this region is poorly understood. Increasing the number of wind farms in the region will increase the chance that a frequently used migratory pathway could be impacted.

The construction of the Project would result in the addition of 80 turbines which corresponds to a 32% increase in the total number of turbines in the region. The degree to which the Project will contribute to the overall cumulative impact is unknown. Data collected during autumn 2019 suggest that whilst the Project Area is located within an area that large bent-winged bats migrate through (Dwyer 1969) there is no evidence that a highly utilised autumn migratory path intersects the Project Area. Examination of mortality rates in the Project Area and at wind farms in the region through robust post-construction monitoring programs is required in order to estimate the magnitude of cumulative impacts on this species in this particular region.

7.0 Predict and map the likely zone of disturbance around wind turbines for aerial species resident in, or likely to fly over, the project area, with reference to relevant literature and other published sources of information

There is currently no information on the degree to which wind turbines disturb aerial species in Australia. For this reason, the likely zone of disturbance around wind turbines is unknown.

8.0 Map significant landscape and habitat features within the zone of disturbance for species likely to be affected, including but not limited to hollow bearing trees and important habitat for migratory species

No mapping of significant landscape and habitat feature mapping has been completed for the purpose of this assessment. Instead, for species for which there is clear spatial variability in site occupancy and abundance across the Project Area (i.e. superb parrot and white-fronted chat), specific areas which are likely to be more important than others are discussed in **Section 4.3**. Locations that are considered to present higher risk to certain species and would therefore be a key consideration of post-construction monitoring will be identified and mapped in the Bird and Bat Adaptive Management Plan (Umwelt, in preparation).

9.0 Predict the likelihood and describe the nature of indirect impacts on aerial species resident in, or likely to fly over, the project area including but not limited to barriers to migratory pathways and breeding, feeding and resting resources

There is currently no information on the degree to which wind turbines create barriers for aerial species in Australia. For this reason, the degree to which the Project may restrict the movement of each of the 14 species assessed in this report is unknown.

10.0 For migratory species, predict the impact of avoidance behaviour relative to migration distances and the availability of suitable habitat for breeding, feeding and resting over the migration route, with reference to relevant literature and other sources of published information

The potential influence that indirect impacts may have on migratory or partly migratory species is difficult to predict given the lack of relevant information available. Species for which a high proportion of their population exhibits migratory behaviour such as white-throated needletail, large bent-winged bat, superb parrot, little eagle and dusky woodswallow, may be more likely to be affected by indirect impacts than sedentary species though the magnitude and nature of such impacts on each is unknown.

11.0 Justify predictions of likelihood and nature of impact, with reference to relevant literature and other published sources of information

See response to **Section 9.0.**

12.0 Predict the cumulative impacts of the project together with existing wind farms with respect to movement patterns and use of adjacent habitat and provide justification for these predictions

There is currently no information on the degree to which wind farms effect movement patterns or use of adjacent habitat for any species in Australia. For this reason, the cumulative impacts of indirect impacts on movement patterns and use of adjacent habitat throughout the region in which the Project Area is located is not predicted.

13.0 Conclusion

Of the 14 species assessed five are considered a high risk, six are considered a moderate risk and three are considered a minor risk of being impacted by the Project (**Table 13.1**). The resultant risk rating for these species is primarily due to their relative abundance in the Project Area, their predicted or observed flight behaviour in the Project Area and/or their known susceptibility to blade strike at wind farms in south-east Australia. For each of the five species assigned an overall risk rating of high, the likelihood of collisions was considered high whilst the consequence of collisions was considered moderate.

The risk rating for the black falcon and little eagle largely reflects the potentially high consequence of small numbers of instances of blade strike of this species. The risk rating for white-throated needletail largely reflects the high likelihood of collision of birds in the Project Area given their known susceptibility to blade strike at other wind farms in Australia and the number and nature of observations in the Project Area during 2018/19. The risk rating for superb parrot and large bent-winged bat partly reflects the high importance of the greater region for both species, combined with factors such as the number and nature of observations in the Project Area.

Table 13.1 Risk Assessment Summary

Common Name	Latin Name	Likelihood	Consequence	Risk Rating
Little eagle	*Hieraaetus morphnoides*	High	Moderate	High
Black falcon	*Falco subniger*	High	Moderate	High
Wedge-tailed eagle	*Aquila audax*	High	Low	Moderate
Superb parrot	*Polytelis swainsonii*	High	Moderate	High
White-throated needletail	*Hirundapus caudacutus*	High	Moderate	High
White-fronted chat	*Epthianura albifrons*	High	Low	Moderate
Brown treecreeper	*Climacteris picumnus victoriae*	Low	Moderate	Minor
Varied sittella	*Daphoenositta chrysoptera*	Moderate	Low	Minor
Painted honeyeater	*Grantiella picta*	Moderate	Moderate	Moderate
Dusky woodswallow	*Artamus cyanopterus*	High	Low	Moderate
Large bent-winged bat	*Miniopterus schreibersii oceanensis*	High	Moderate	High
Yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	Moderate	Moderate	Moderate
Southern myotis	*Myotis macropus*	Low	Moderate	Minor
Eastern false pipistrelle	*Falsistrellus tasmaniensis*	Moderate	Moderate	Moderate

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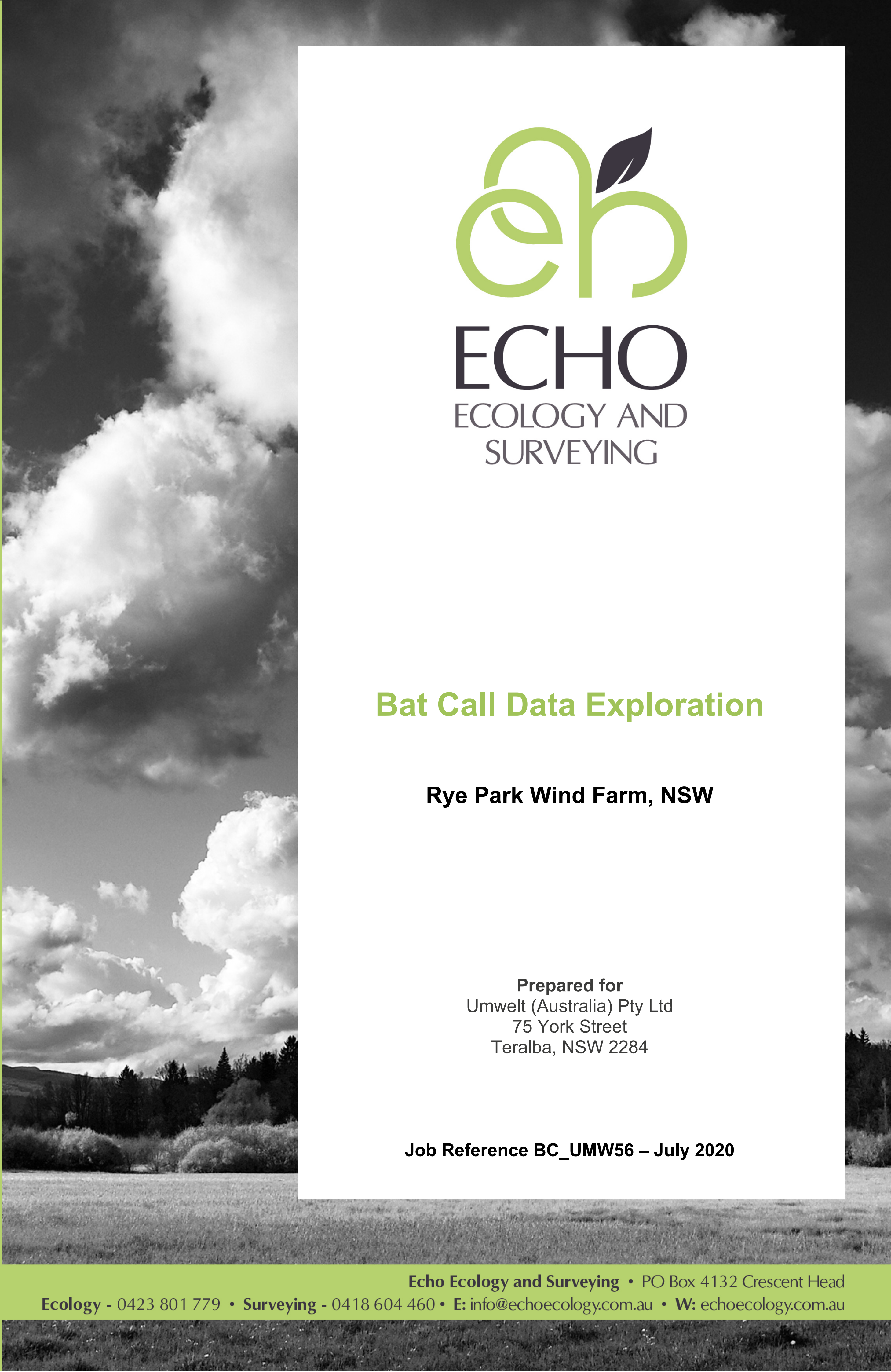
APPENDIX E1

Bat Call Data Exploration Report



ECHO
ECOLOGY AND SURVEYING

Bat Call Data Exploration

Rye Park Wind Farm, NSW

Prepared for
Umwelt (Australia) Pty Ltd
75 York Street
Teralba, NSW 2284

Job Reference BC_UMW56 – July 2020

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This report has been prepared to document the analysis of digital ultrasonic bat echolocation data received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

This report was authored by

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Job Reference: BC_UMW56
13 July 2020

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1.0 INTRODUCTION

This report has been commissioned by Umwelt (Australia) Pty Ltd to explore trends in the echolocation call data collected from Rye Park, NSW.

Comments have been received from the NSW Government requesting further information. The relevant received from the NSW Government are as follows:

BCD commends the Applicant for the large number of sites surveyed both at ground level and elevation for microbats. However, there are a large number of 'possible' Large Bent-winged Bat calls in shown in Tables 4.3 and 4.4, relative to the number of 'definite' and 'probable' calls. This a trigger for further and more detailed investigation. It is recommended that the following information is provided:

- Description on the method used to classify calls into 'definite' 'probably and 'possible' categories.
- Information on the temporal distribution of the possible calls in terms of mean number of calls per hour and per day including whether there any noticeable spikes in activity or were these calls a consistent 'background' noise.
- Information on whether there a similar level of uncertainty about the number of calls detected for Eastern False Pipistrelle, Yellow-bellied Sheathtail bat and Southern Myotis.

The first and third comments above have been addressed in the original bat call identification report prepared for the project: Echo Ecology and Surveying 2020 *Bat Call Identification: Rye Park Wind Farm, NSW*, prepared for Umwelt (Australia) Pty Ltd. We recommend supplying this report to BCD.

The overall aim of this report is to provide further data analysis of the bat call data for the Rye Park Wind Farm project. In particular,

- Use descriptive statistics and/or graphs to explore possible *Miniopterus orianae oceanensis* activity patterns:
    - the seasonal activity patterns (e.g. comparing mean nightly activity) of possible *M.o.oceanensis* calls with the aim of detecting any activity 'spikes' that may indicate *M.o.oceanensis* seasonal migration;
    - the nightly activity patterns (activity per hour) of possible *M.o.oceanensis* calls with the aim of determining nightly activity peaks
    - elevational activity patterns (e.g. 2m and 45m AGL sites) to determine whether possible *M.o.oceanensis* activity trends at height are similar to those at ground (seasonal and nightly)
- Review the seasonal and activity patterns of the other bat species with potential to occur at the site using similar methods as above.

2.0 METHODS

File identification reports were extracted from previously identified bat calls (Echo Ecology and Surveying, 2020) in Anabat Insight (Version 1.9.3, Titley Electronics) to tally the number of passes per species (or species group) per night and per hour.

As very few confident *M.o.oceanensis* identifications were made, we pooled these with all calls that may have been possibly from *M.o.oceanensis* to create a "possible *M.o.oceanensis*" dataset (often abbreviated in graphs and text as "Moo / Vespadelus"). This included the following species identifications:

- *Miniopterus orianae oceanensis* (Definite)
- *Chalinolobus morio / Miniopterus orianae oceanensis / Vespadelus vulturnus*
- *Miniopterus orianae oceanensis / Vespadelus darlingtoni / Vespadelus regulus / Vespadelus vulturnus*
- *Miniopterus orianae oceanensis / Vespadelus regulus*
- *Miniopterus orianae oceanensis / Vespadelus regulus / Vespadelus vulturnus*
- *Miniopterus orianae oceanensis / Vespadelus vulturnus*

As *M.o.oceanensis* most frequently overlaps in characteristics with *Vespadelus* spp. we also created a possible *Vespadelus* spp dataset (often abbreviated in graphs as "Vespadelus spp.") that included the following identifications:

- *Vespadelus vulturnus (Definite, Probable, Possible)*
- *Vespadelus darlingtoni (Definite, Probable, Possible)*
- *Vespadelus darlingtoni / Vespadelus regulus*
- *Vespadelus darlingtoni / Vespadelus regulus / Vespadelus vulturnus*
- *Vespadelus regulus / Vespadelus vulturnus*
- *Chalinolobus morio / Vespadelus vulturnus*

For the analyses and graphs involving other species, we only used confident classifications (Definite and Probable pooled together).

For the purposes of exploring the data we assigned sample dates to the categories outlined in Table 2-1 based on *M.o.oceanensis* breeding and migration status. The purpose of these categories were to allow a review of what 'background' activity patterns may be at different times of year. The Autumn migration start date is reasonably accurate based on those provided to Umwelt by the NSW Government. The other dates have been roughly extrapolated based on this Autumn migration date and only include the dates that were sampled.

Table 2-1: *M.o.oceanensis* season breeding and migration status dates

Moo Season	Date Start	Date End
1.Staging	5/11/2018	1/12/2018
2.Maternity	21/01/2019	18/03/2019
3.Weaning	18/03/2019	24/03/2019
4.AutumnMigration	25/03/2019	10/04/2019
5.Post-Migration	11/04/2019	1/05/2019

We added the following variables to the data:

- Site name
- Night
- Month
- Elevation (from ground)
    - 2m
    - 45m
- Habitat Type
    - Cleared Hilltop
    - Forest includes woodland and forest/woodland edge sites
    - Riparian
- Moo Season
    - 1.Staging
    - 2.Maternity
    - 3.Weaning
    - 4.Autumn Migration
    - 5.Post-Migration

Site details are provided in Appendix A.

We excluded nights with missing or incomplete data as best we could determine from microphone errors in log files, notes from the field ecologists and rainy nights where no data was recorded after a certain time (likely due to rain droplets covering the microphone).

To investigate seasonal activity levels we calculated average nightly site activity (average no. passes per site) for each seasonal category (Moo Season or Month), then graphed the mean ± SE of the average nightly activity. Whereas, hourly data graphs have pooled data (not first averaged per site).

All analyses and graphs were prepared using JMP (Version 15.1.0, SAS Institute Inc.).

2.1 Limitations

We have undertaken basic descriptive statistics and graphing to explore activity patterns. More complex statistical models and analyses may be able to better account for the effects of site, habitat type and differences in sample dates. However, this requires advanced statistics methods and is beyond the scope of this report.

We have most often used mean ± SE to summarise bat activity as it is easily viewed on graphs, but it should be noted that median values are often much lower.

3.0 RESULTS & DISCUSSION

A total of 1107 sample nights were included in the analyses from 30 different sites. Descriptive statistics are provided in Table 3-1 below (all nights pooled).

Table 3-1: Descriptive statistics for total bat activity and Moo / Vespadelus activity by variable. Results per night, all sites pooled.

Variable		n	Total Bat Activity				Moo/Vespadelus Activity			
			Mean	Median	SE	Range	Mean	Median	SE	Range
Month	Nov-18	262	188.98	66.5	15.64	0-3002	43.96	2	5.67	0-1910
	Jan-19	115	247.72	150	23.61	6-1995	41.46	4	8.56	0-534
	Feb-19	223	224.92	132	16.96	3-1381	29.61	1	6.14	0-620
	Mar-19	349	124.81	77	13.55	0-1057	1.28	0	4.91	0-23
	Apr-19	158	116.94	20.5	20.14	0-1624	27.04	0	7.30	0-725
Elevation	2m	744	216.22	112.5	9.15	0-3002	36.89	2	3.36	0-1910
	45m	363	80.79	46	13.10	0-523	0.43	0	4.81	0-27
Habitat Type	Cleared Hilltop	815	111.03	63	8.28	0-1057	1.93	0	2.97	0-131
	Forest	215	326.24	206	16.12	0-2762	82.49	32	5.78	0-1910

Variable		n	Total Bat Activity				Moo/Vespadelus Activity			
			Mean	Median	SE	Range	Mean	Median	SE	Range
	Riparian	77	383.97	246	26.93	0-3002	107.71	52	9.66	0-927
Moo Season	1.Staging	262	188.98	66.5	15..61	0-3002	43.96	2	5.72	0-1910
	2.Maternity	549	208.81	126	10.78	3-1995	21.33	1	3.95	0-620
	3.Weaning	72	87.50	50.5	29.78	6-575	1.07	0	10.92	0-15
	4.Autumn Migration	209	88.75	16	17.48	0-1624	19.88	0	6.41	0-725
	5.Post-Migration	15	79.53	25	65.24	6-346	9.80	0	23.92	0-45

3.1 Habitat Type

3.1.1 *Miniopterus orianae oceanensis*

Overall, Moo / Vespadelus spp. activity was much lower at cleared hilltop sites than either forest or riparian sites (Figure 3-1). This pattern is consistent when split by *M.o.oceanensis* season (not graphed here).

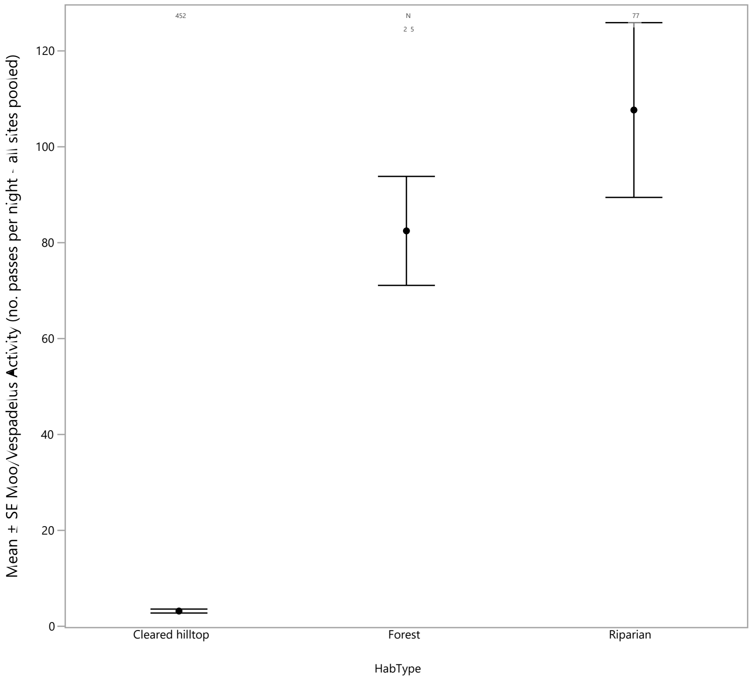

Figure 3-1: Mean ± SE nightly *Moo / Vespadelus* spp. activity by habitat type. All sites pooled and 45m sites excluded. n is shown at the top of the graph

3.2 Seasonal Activity Patterns

3.2.1 *Miniopterus orianae oceanensis*

There is no clear and consistent spike in Moo/Vespadelus activity during the Autumn migration season. When all activity data is pooled together (45m elevation sites excluded), there appears to be an increase in activity during the Autumn Migration period compared to both Weaning and Post-migration (Figure 3-2). However, when investigated by habitat type (Figure 3-3) or per site (see Appendix B), the trend appears to be a result of unequal sampling effort among the seasons (ie not all sites were sampled in every season and sampling was not always concurrent among sites). In this case, the ‘Cleared Hilltop’ sites are the only sites sampled during the ‘Weaning’ season and these sites typically had much lower activity levels than forest or riparian habitats. As such, we have often subset graphs by habitat type and we have included graphs of activity levels for individual sites in Appendix B so that these ‘spikes’ can be viewed in the context of site activity and sample effort.

In addition, activity patterns of Moo/Vespadelus are very similar to those of the *Vespadelus* spp. group (Figure 3-3) suggesting that other factors may also be influencing activity levels.

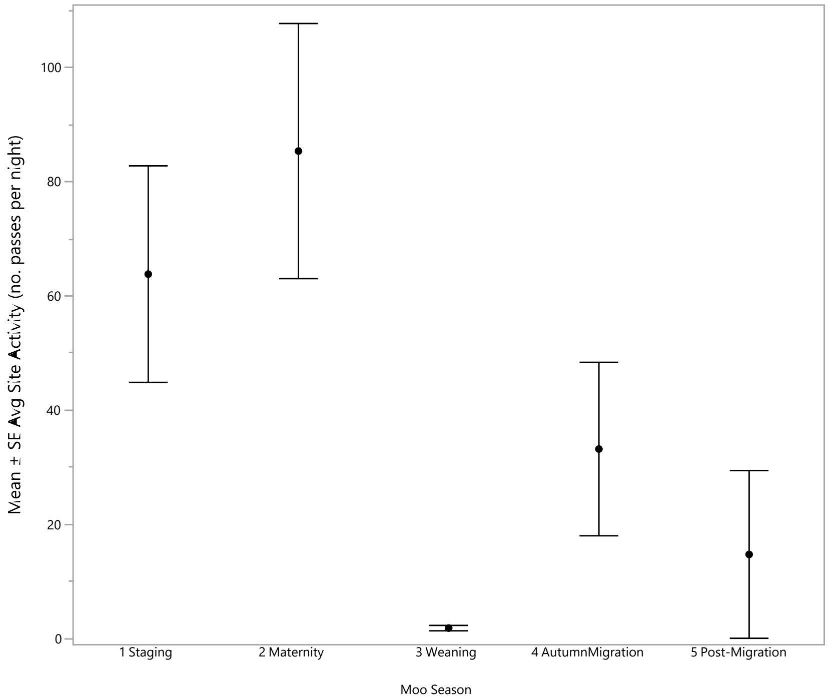

Figure 3-2: Mean ± SE Average nightly *Moo / Vespadelus* spp. activity by Moo season. 45m sites excluded.

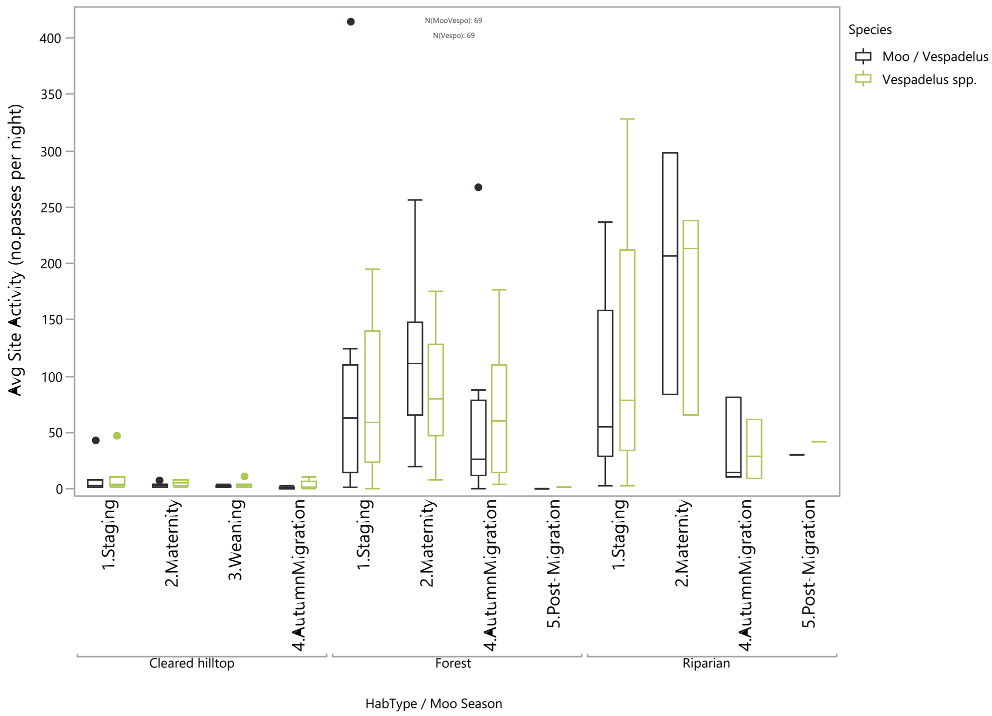

Figure 3-3: Average Site *Moo / Vespadelus* spp. and *Vespadelus* spp. activity by Moo season and habitat type. 45m sites excluded. n is shown at the top of the graph

Individual nights of high Moo/Vespadelus activity were detected as outliers in Figure 3-4; Figure 3-5; Figure 3-6 for sites BGIRP2, BGIRP3, BGIYAS, BGIRP8, BGI02 and BGI12. Activity on the 23/3/2019 at cleared hilltop sites and on 3/4/2019 at forested sites also appears to be greater than surrounding dates (though variable as indicated by the large boxplot range). The high activity on 3/4/2019 (Figure 3-5) appears to be driven (as indicated by relatively low median value and large box plot range) by activity spikes at Site BGI02 and Site BGI09 on 3/4/2019 where 725 and 383 Moo/Vespadelus passes were recorded respectively (see Appendix B). Sample sizes for riparian sites are quite low either side of the *M.o.oceanensis* Autumn migration period and interpretation of this data should be cautious (Figure 3-6).

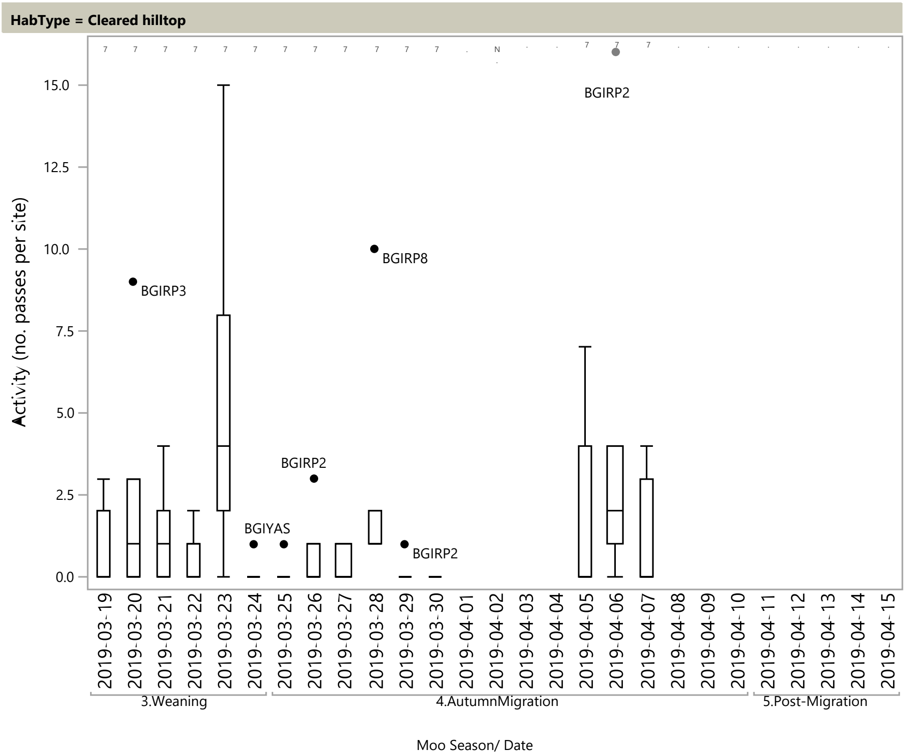

Figure 3-4: Cleared Hilltop Nightly *Moo/Vespadelus* spp. activity surrounding the Moo Autumn Migration season by habitat type. All sites pooled, cleared hilltop habitat only and 45m sites excluded. n is shown at the top of the graph and all outliers are labelled with site name

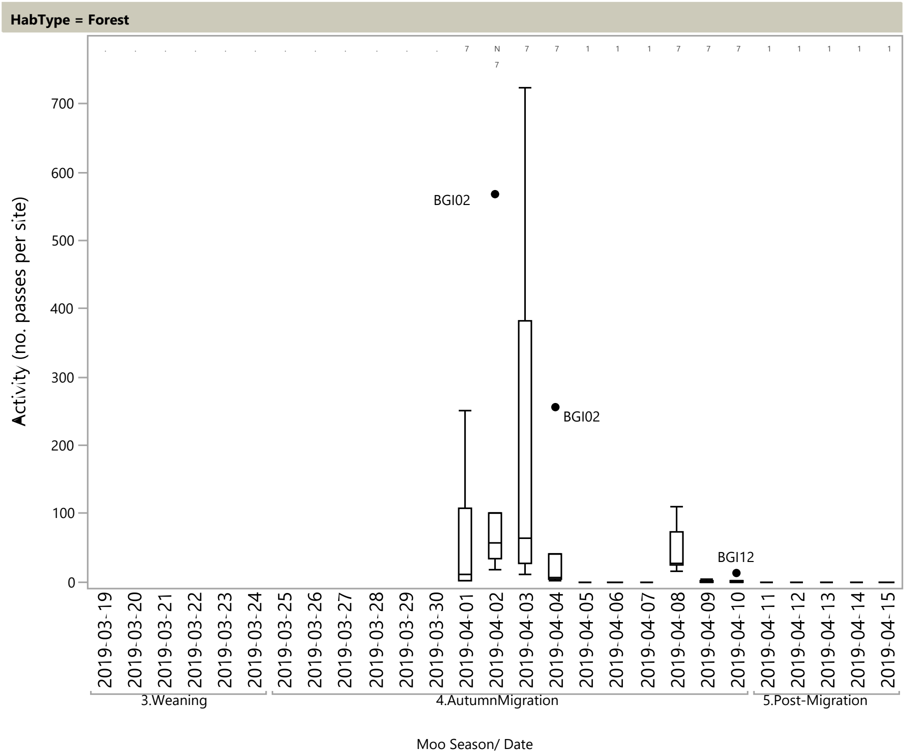

Figure 3-5: Forest Nightly *Moo/Vespadelus* spp. activity surrounding the Moo Autumn Migration season by habitat type. All sites pooled, forest habitat only and 45m sites excluded. n is shown at the top of the graph and all outliers are labelled with site name

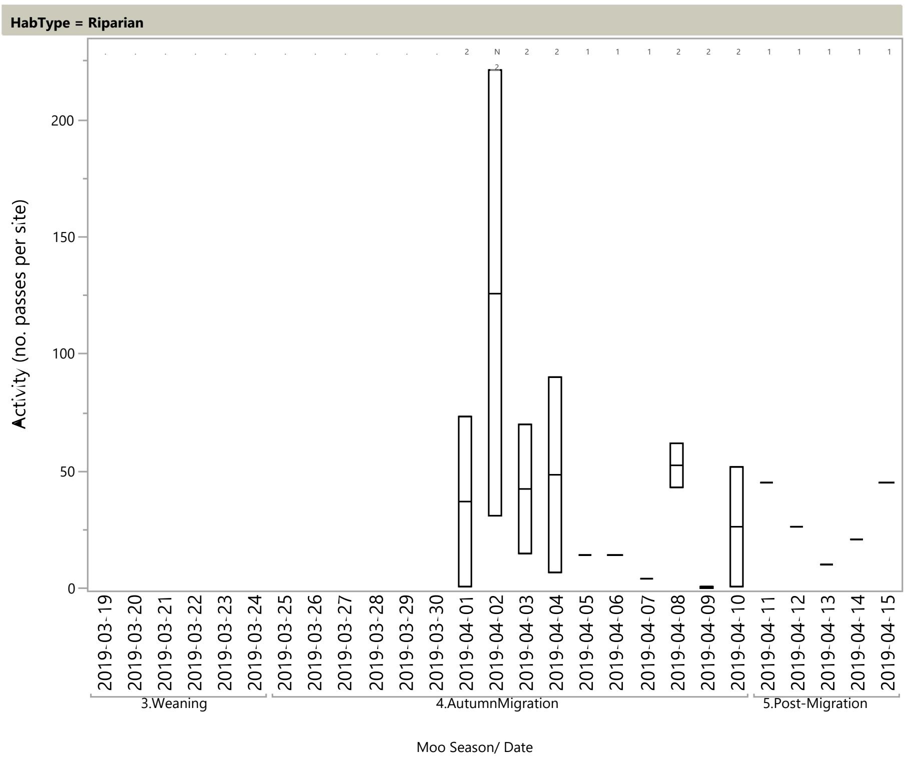

Figure 3-6: Riparian Nightly *Moo/Vespadelus* spp. activity surrounding the Moo Autumn Migration season by habitat type. All sites pooled, riparian habitat only and 45m sites excluded. n is shown at the top of the graph and all outliers are labelled with site name

3.2.2 Other Bat Species

Total bat activity was variable among sites, with April showing less activity overall than all other months (Figure 3-7)

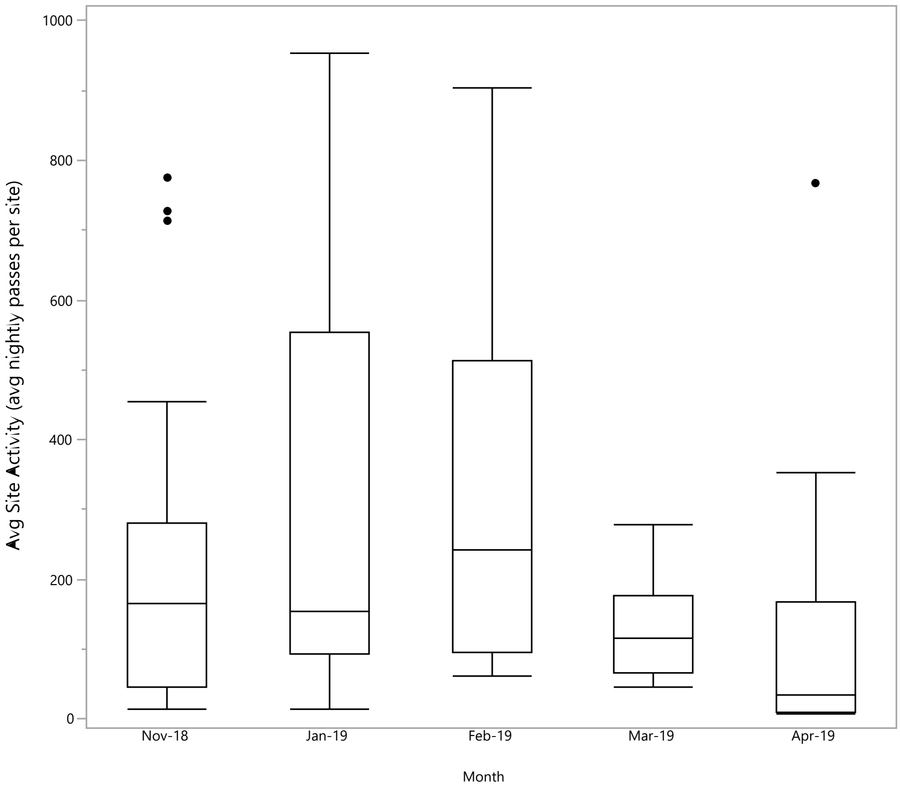

Figure 3-7: Average Total Bat Activity (average nightly passes per site) by month.

Direct comparison of activity levels among species is not recommended due to differences in detection and identification probabilities for each species. However, exploring whether there are seasonal changes in activity for each species may be useful for wind turbine operation.

Austronomus australis displayed the most obvious seasonal trend, showing high summer activity which decreased in spring and autumn in all habitat types (Figure 3-8). It is speculated by some researchers that *Austronomus australis* may migrate during winter in southern Australia and this may explain this activity pattern. However, other factors may also be responsible for this pattern such as maternity roost location, insect abundance or young beginning to fly.

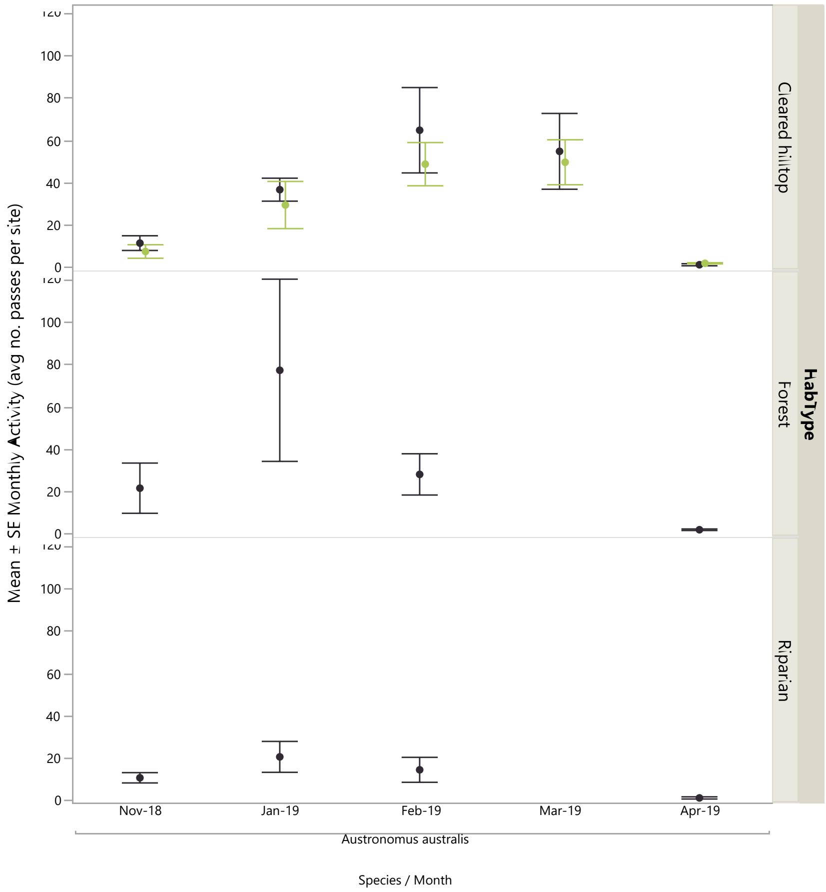

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Figure 3-8: Mean ± SE *Austronomus australis* Average nightly activity by month and habitat type.

The seasonal trend of other species is presented below in Figure 3-9, Figure 3-10 and Figure 3-11.

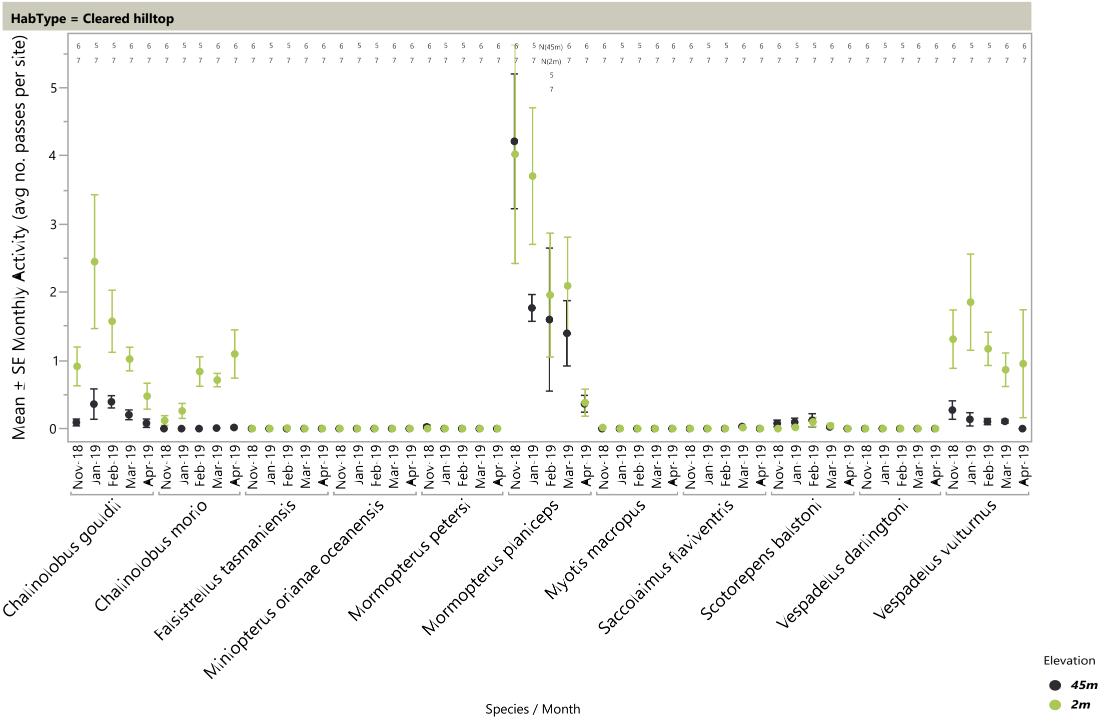


Figure 3-9: Cleared Hilltop Mean ± SE bat average nightly activity by month and habitat type.. Cleared hilltop habitat only. *Austronomus australis* excluded. n shown at top of graph.

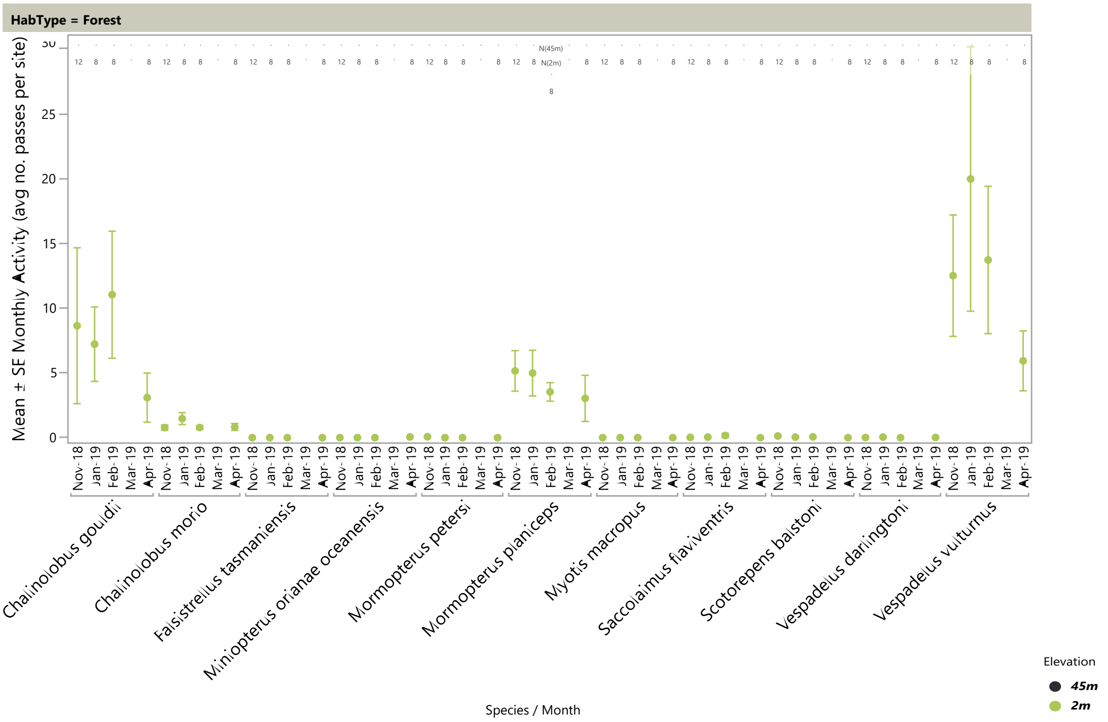


Figure 3-10: Forest Mean ± SE bat average nightly activity by month and habitat type. Forest habitat only. *Austronomus australis* excluded. n shown at top of graph.

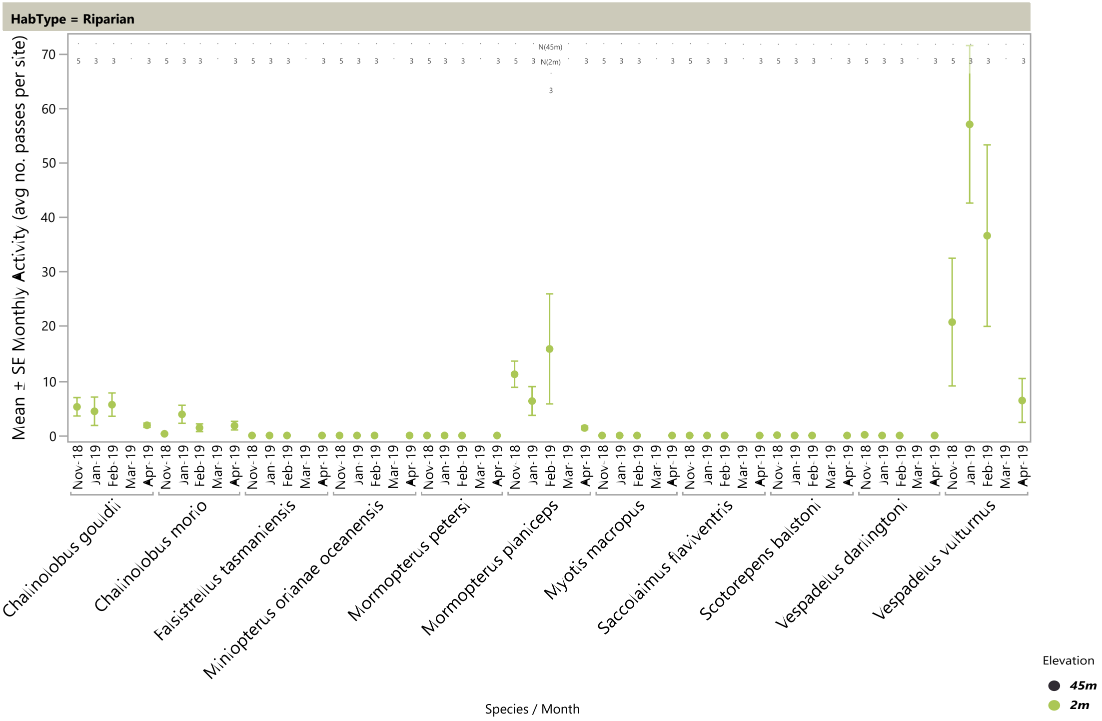


Figure 3-11: Riparian Mean ± SE bat average nightly activity by month and habitat type.. Riparian habitat only. *Austronomus australis* excluded. n shown at top of graph.

3.3 Elevational Activity Patterns

3.3.1 *Miniopterus orianae oceanensis*

A similar trend in seasonal Moo/Vespadelus and Vespadelus spp. activity is found at both 2m and 45m above ground elevation sites (Figure 3-12).

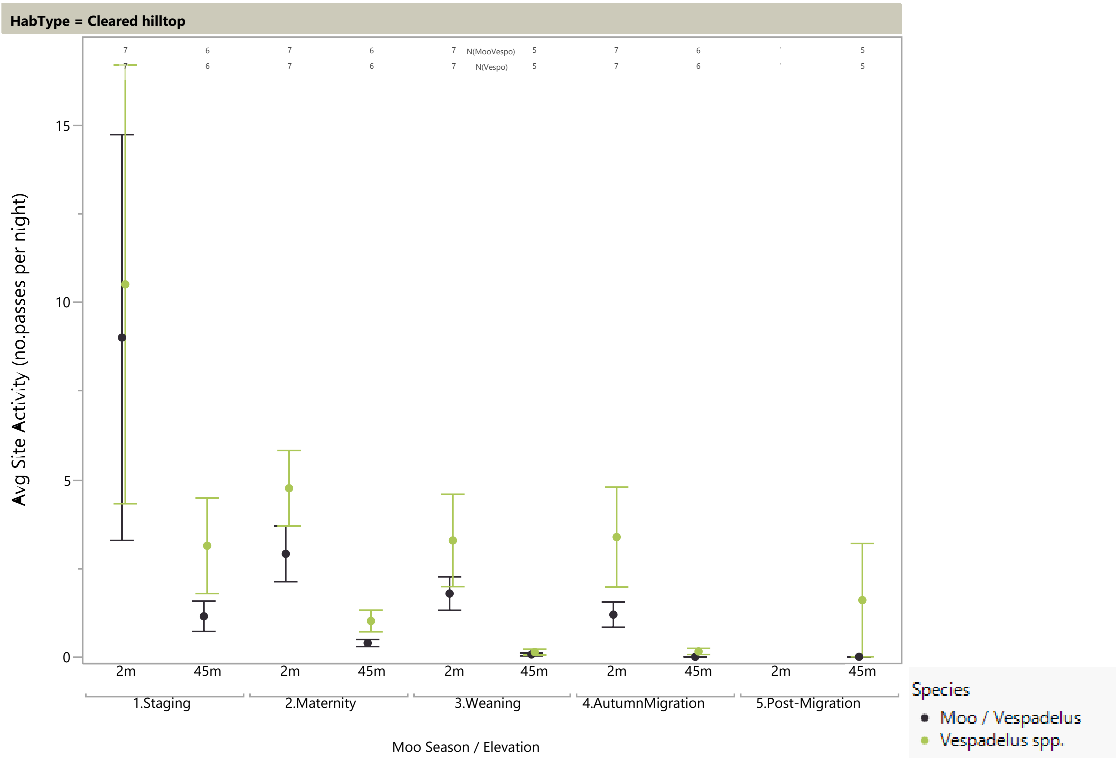


Figure 3-12: Mean ± SE average nightly *Moo / Vespadelus* spp. and *Vespadelus* spp. activity by Moo season and elevation from ground. Cleared Hilltop sites only. n is shown at the top of the graph

3.3.2 Other Bat Species

A total of eight species were confidently recorded (Definite and Probable identifications) at the 45m elevation above ground sites (Figure 3-9), being:

- *Austronomus australis;*
- *Chalinolobus gouldii;*
- *Chalinolobus morio;*
- *Mormopterus petersi;*
- *Mormopterus planiceps;*
- *Saccolaimus flaviventris;*
- *Scotorepens balstoni; and*
- *Vespadelus vulturnus.*

Only *Austronomus australis* and *Mormopterus planiceps* showed consistent activity at the 45 m elevation sites (Figure 3-8; Figure 3-9);. *Chalinolobus gouldii, Scotorepens balstoni* and *Vespadelus vulturnus* showed occasional low activity (Figure 3-9) and the remaining species (*Chalinolobus morio, Mormopterus petersi* and *Saccolaimus flaviventris*) had only 1-2 passes on 1-2 separate nights.

Austronomus australis showed only slightly lower activity levels at the 45m sites as the 2m sites (Figure 3-8). *Chalinolobus gouldii* and *Vespadelus vulturnus* were much more active at the 2m above ground sites, than the 45m sites (Figure 3-9).

3.4 Nightly Activity Patterns

3.4.1 *Miniopterus orianae oceanensis*

The nightly activity patterns of Moo/Vespadelus calls by *M.o.oceanensis* season are presented in Figure 3-13, Figure 3-14 and Figure 3-15 below.

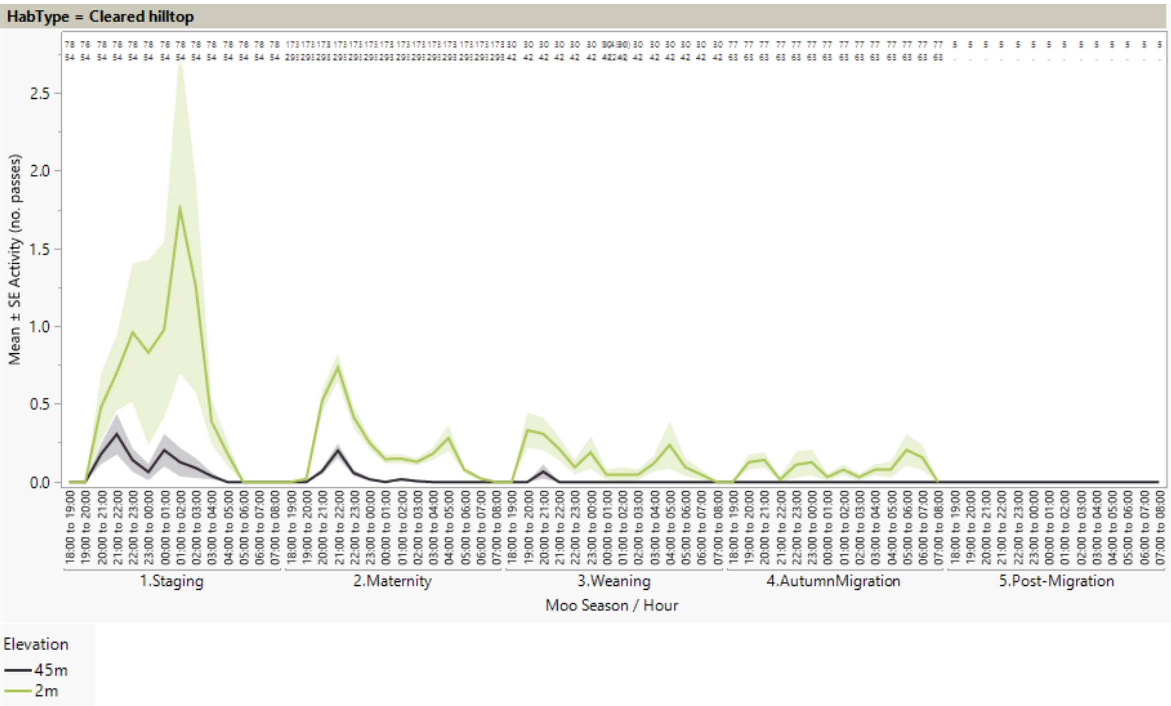


Figure 3-13: Mean ± SE hourly *Moo/Vespadelus* spp. activity by hour, Moo season and elevation from ground. Cleared Hilltop sites only. All sites pooled. n is shown at the top of the graph. Times have not been converted to time since sunset.

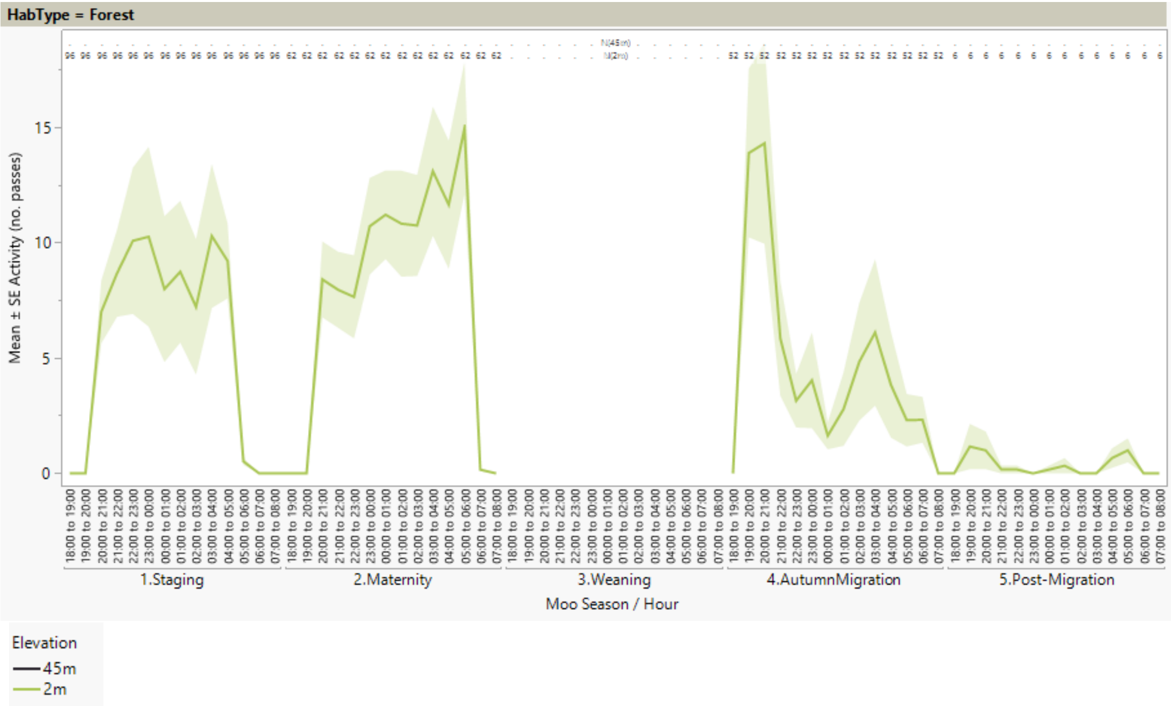


Figure 3-14: Mean ± SE hourly *Moo/Vespadelus* spp. activity by hour, Moo season and elevation from ground. Forest sites only. All sites pooled. n is shown at the top of the graph. Times have not been converted to time since sunset.

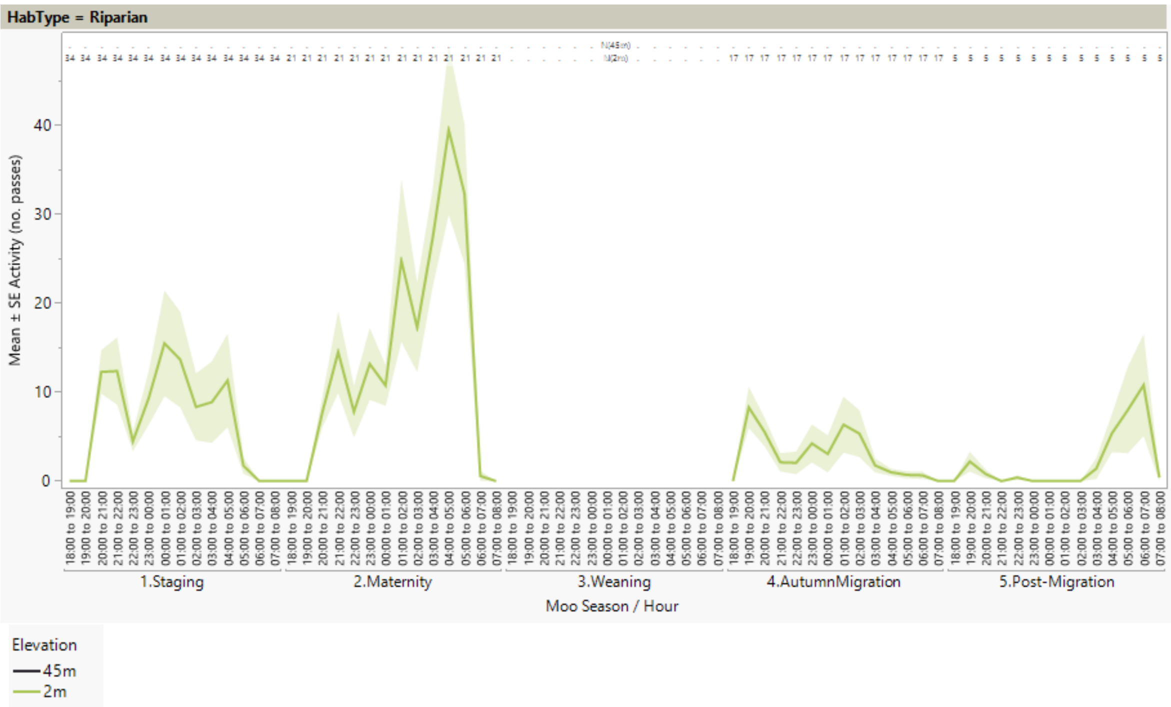


Figure 3-15: Mean ± SE hourly *Moo/Vespadelus* spp. activity by hour, Moo season and elevation from ground. Riparian sites only. All sites pooled. n is shown at the top of the graph. Times have not been converted to time since sunset.

3.4.2 Other Bat Species

During warmer months total bat activity peaked on dusk and then gradually dropped off after midnight (Figure 3-16). However, in April, when conditions are often cooler, bat activity peaks on dusk and drops off much more steeply after the first 2-3 hours (Figure 3-16).

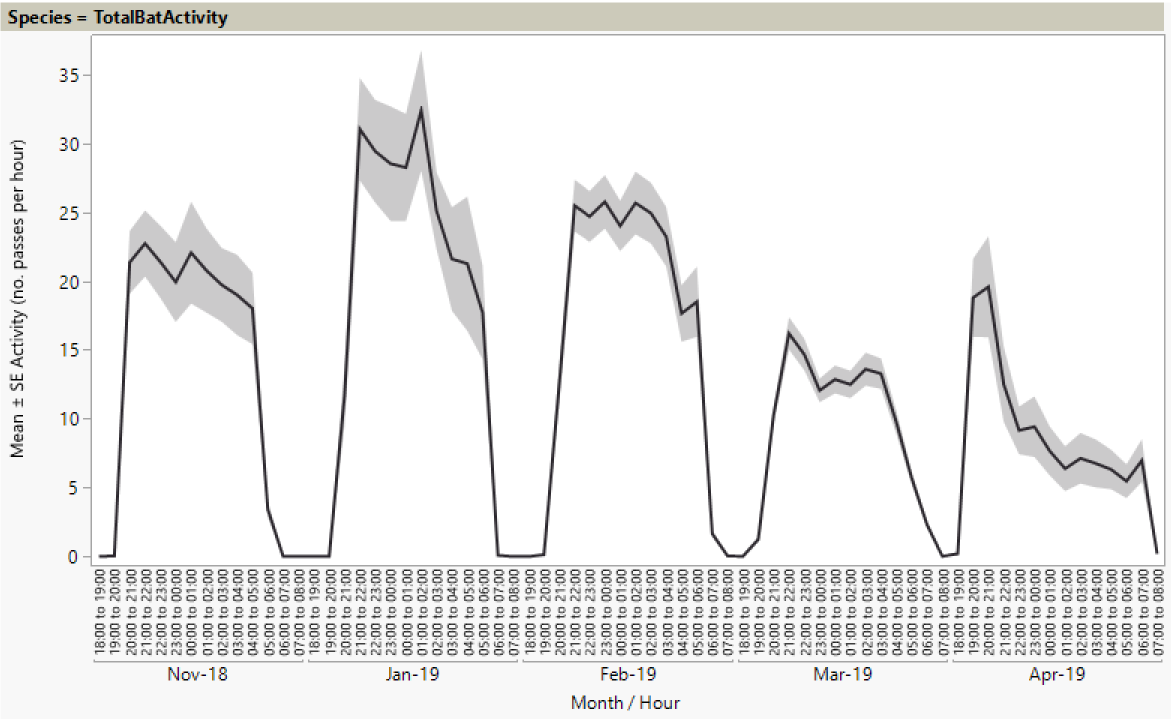


Figure 3-16: Mean ± SE hourly total bat activity by month. All sites pooled. Times have not been converted to time since sunset.

The nightly activity patterns for other bat species (only species with > 0.5 average passes per hour have been included in graphs) are shown below in Figure 3-17, Figure 3-18, Figure 3-19 and Figure 3-20.

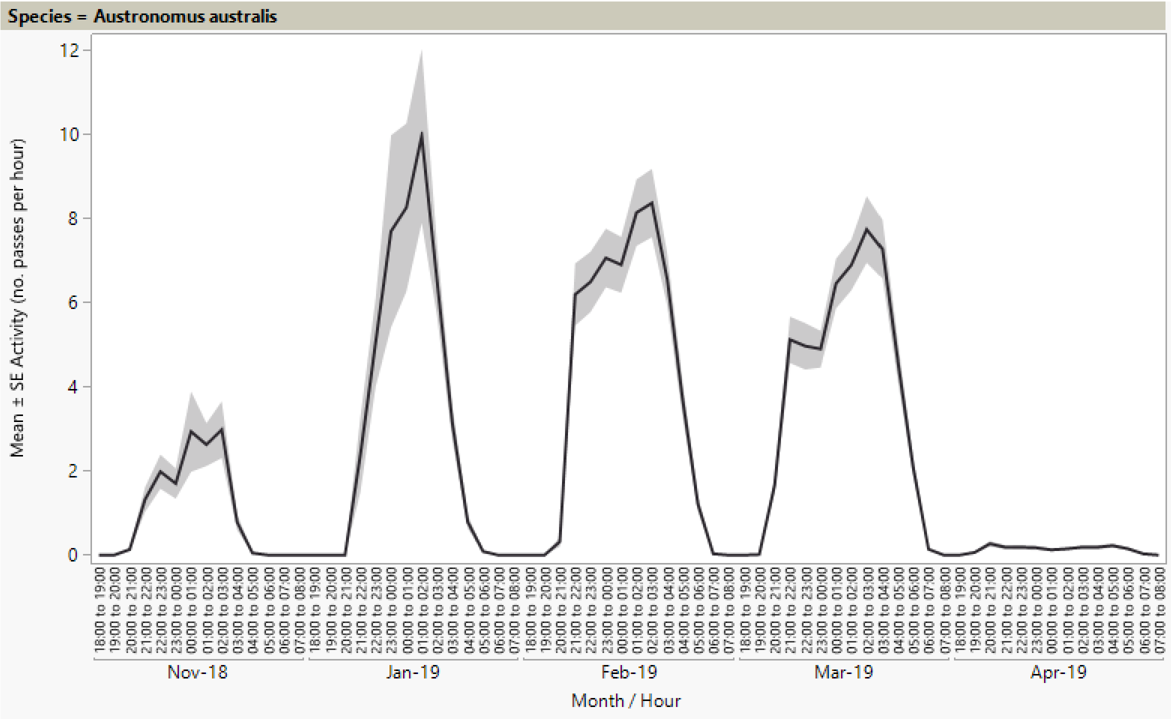


Figure 3-17: Mean ± SE hourly *Austronomus australis* activity by month. All sites pooled. Times have not been converted to time since sunset.

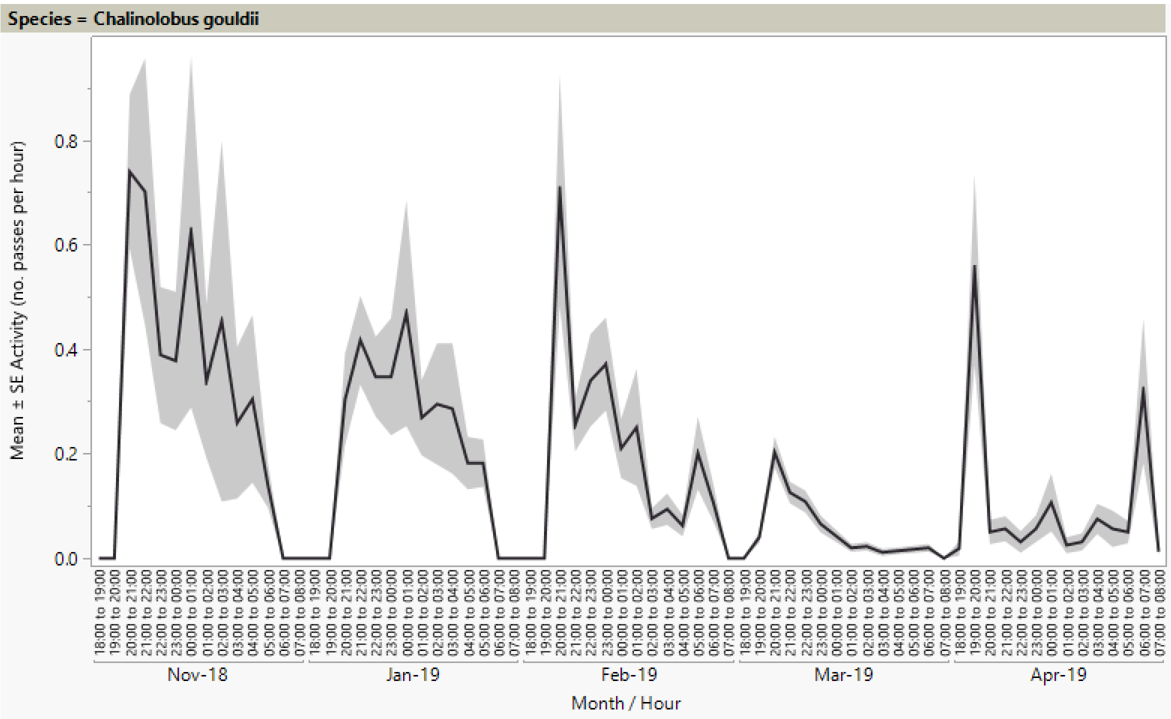


Figure 3-18: Mean ± SE hourly *Chalinolobus gouldii* activity by month. All sites pooled. Times have not been converted to time since sunset.

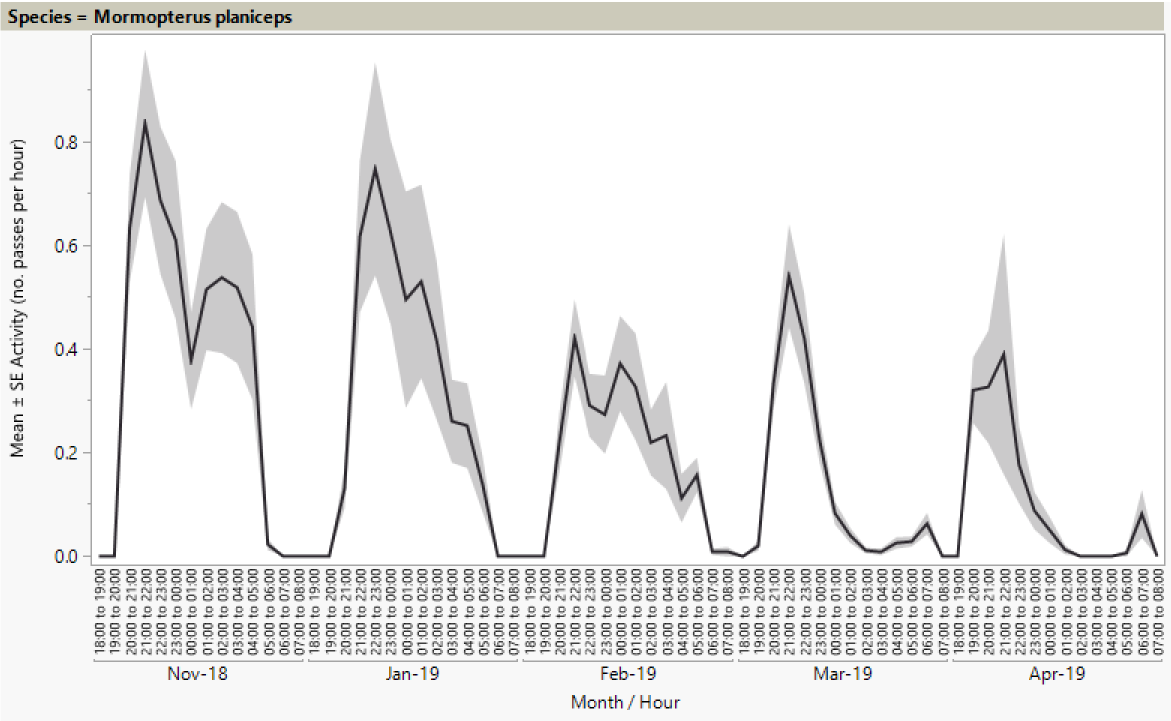


Figure 3-19: Mean ± SE hourly *Mormopterus planiceps* activity by month. All sites pooled. Times have not been converted to time since sunset.

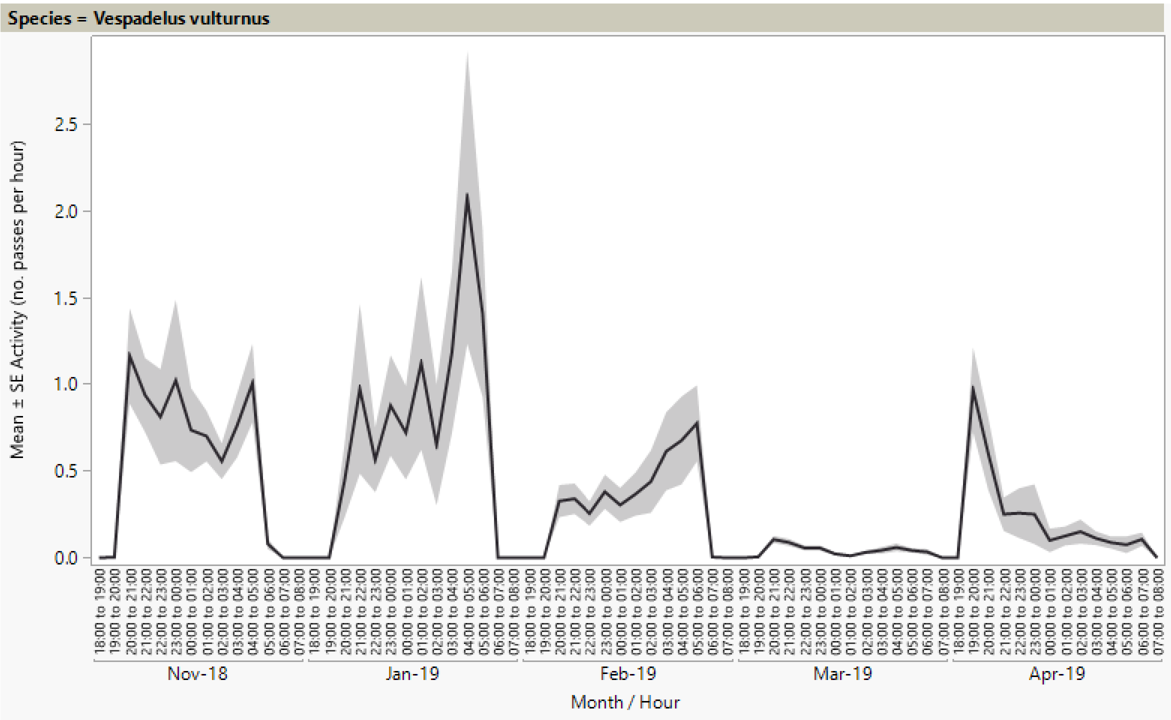


Figure 3-20: Mean ± SE hourly *Vespadelus vulturnus* activity by month. All sites pooled. Times have not been converted to time since sunset.

4.0 REFERENCES

Echo Ecology and Surveying 2020 *Bat Call Identification: Rye Park Wind Farm, NSW*, prepared for Umwelt (Australia) Pty Ltd.

APPENDIX A SITE DETAILS

Site	HabType	Elevation	Description
BGC01	Riparian	2m	Paddock tree amongst scattered E. melliodora, water in minor creek approx. 30 m from detector.
BGC02	Riparian	2m	Paddock tree amongst scattered E. melliodora, water in minor creek approx. 30 m from detector.
BGC03	Riparian	2m	On box-gum woodland edge, over shallow gully with dense Typha.
BGC04	Forest	2m	On edge of open box-gum woodland and *E. rossii/ E. macrorhyncha* dry sclerophyll forest.
BGC05	Forest	2m	In dense shrubland.
BGCRP4	Cleared hilltop	2m	Located on bare hilltop
BGI01	Riparian	2m	On box-gum woodland edge, over gully containing occasional small pools.
BGI02	Forest	2m	On edge of small clearing in *E. rossii/ E. macrorhyncha* dry sclerophyll forest.
BGI03	Forest	2m	In patch of *E. rossii/ E. macrorhyncha* dry sclerophyll forest. No water nearby.
BGI04	Forest	2m	Dense *rossii/ E. macrorhyncha* dry sclerophyll forest on hill slope near top of ridge.
BGI05	Forest	2m	Dense *rossii/ E. macrorhyncha* dry sclerophyll forest on hill slope near top of ridge.
BGI06	Forest	2m	In patch of *E. rossii/ E. macrorhyncha* dry sclerophyll forest.
BGI07	Riparian	2m	Paddock tree amongst scattered E. melliodora, water in minor creek approx. 30 m from detector.
BGI08	Forest	2m	In patch of *E. rossii/ E. macrorhyncha* dry sclerophyll forest. No water nearby.
BGI09	Forest	2m	On edge of *E. rossii/ E. macrorhyncha* dry sclerophyll forest near shrubland.
BGI10	Forest	2m	In very small patch of *E. rossii/ E. macrorhyncha* dry sclerophyll forest. Surrounded by shrubland.

Site	HabType	Elevation	Description
BGI11	Forest	2m	In patch of *E. rossii/ E. macrorhyncha* dry sclerophyll forest.
BGI12	Forest	2m	On edge of *E. rossii/ E. macrorhyncha* dry sclerophyll forest above dry gully.
BGIRP2	Cleared hilltop	2m	Located on bare hilltop
BGIRP3	Cleared hilltop	2m	Located on bare hilltop
BGIRP5	Cleared hilltop	2m	Located on bare hilltop
BGIRP6	Cleared hilltop	2m	Located on bare hilltop
BGIRP8	Cleared hilltop	2m	Located on bare hilltop
BGIYAS	Cleared hilltop	2m	Located on bare hilltop
BMCRP 4	Cleared hilltop	45m	Located on bare hilltop
BMIRP2	Cleared hilltop	45m	Located on bare hilltop
BMIRP3	Cleared hilltop	45m	Located on bare hilltop
BMIRP5	Cleared hilltop	45m	Located on bare hilltop
BMIRP6	Cleared hilltop	45m	Located on bare hilltop
BMIRP8	Cleared hilltop	45m	Located on bare hilltop

APPENDIX B PER SITE GRAPHS

Autumn Migration Moo/Vespadelus Activity Per Night Per Site

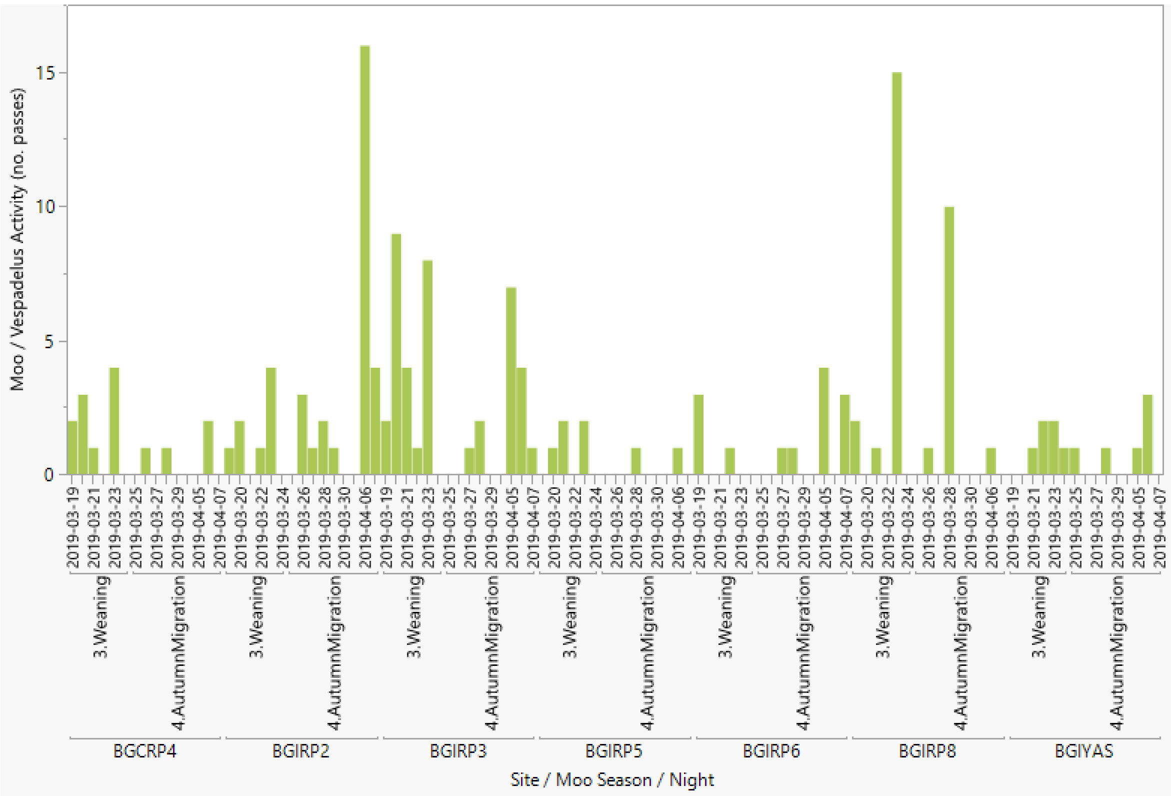


Figure A1: Cleared Hilltop 2m Nightly Moo/Vespadelus activity during the Autumn migration period (including immediately before and after) by site for 2m above ground sites on cleared hilltops only.

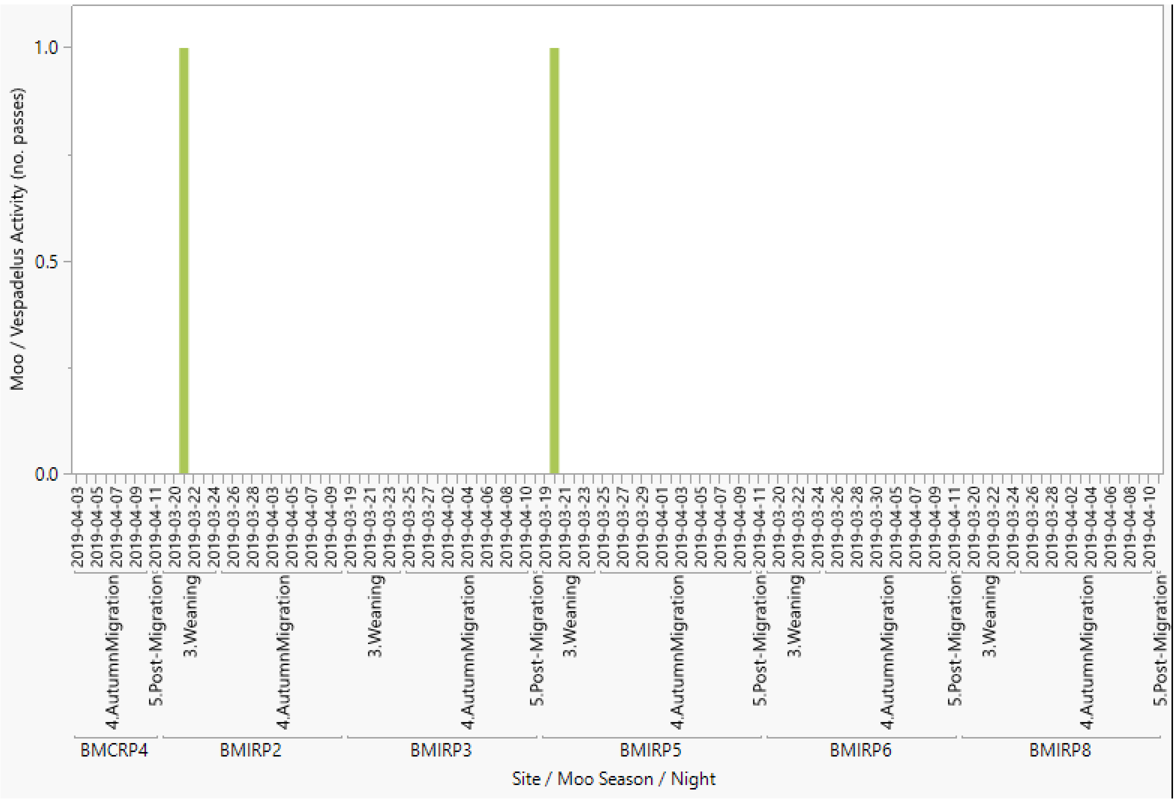


Figure A2: Cleared Hilltop 45m Nightly Moo/Vespadelus activity during the Autumn migration period (including immediately before and after) by site for 45m above ground sites on cleared hilltops only.

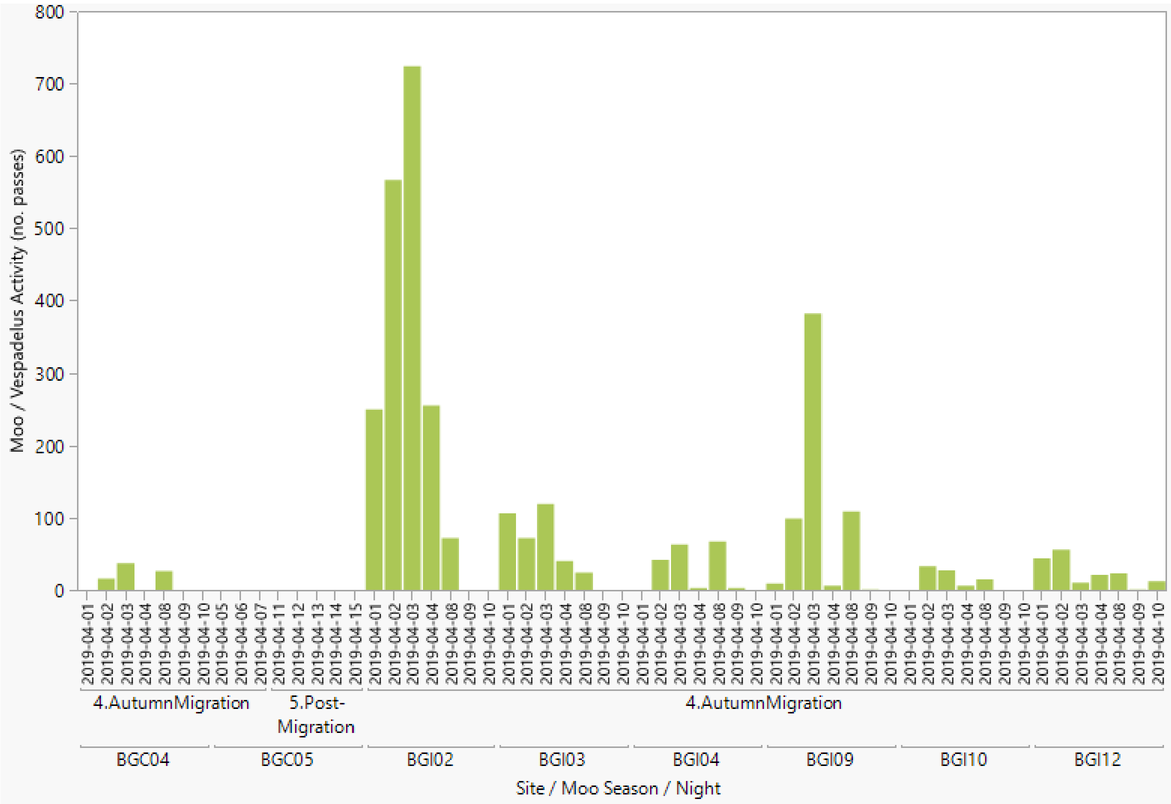


Figure A3: Forest 2m Nightly Moo/Vespadelus activity during the Autumn migration period (including immediately before and after) by site and including forested sites only.

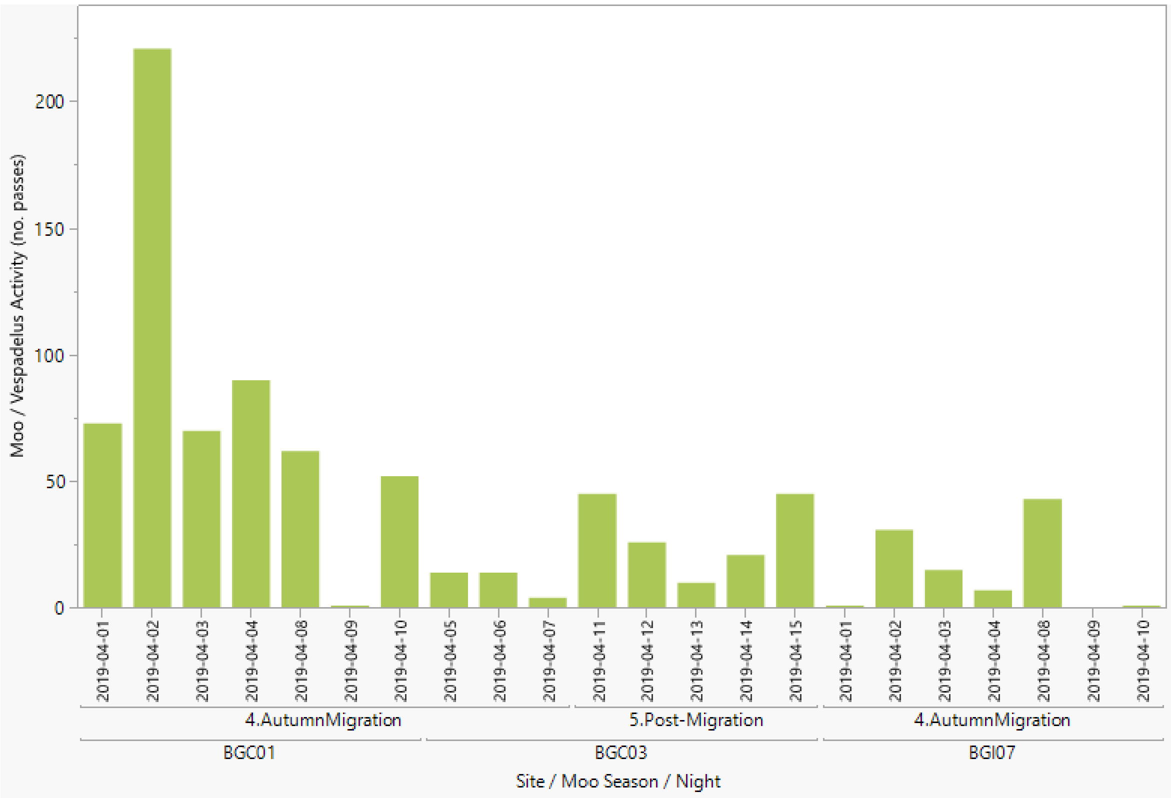
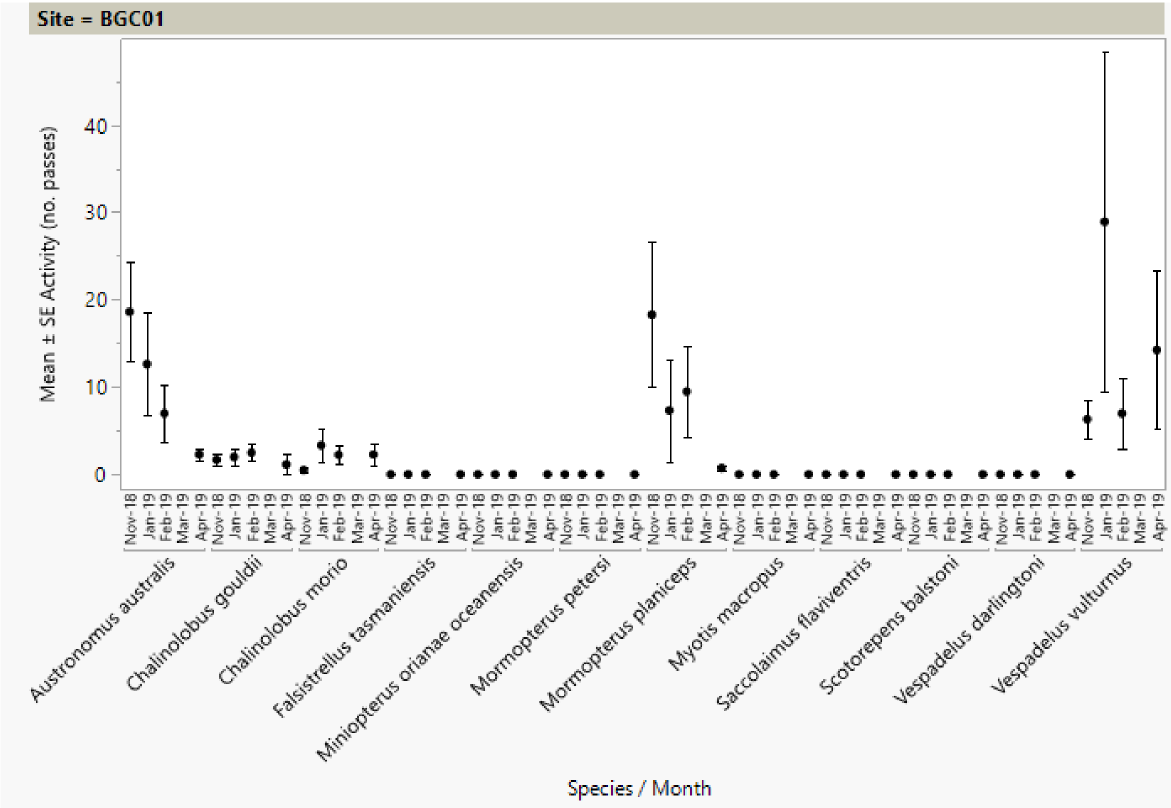
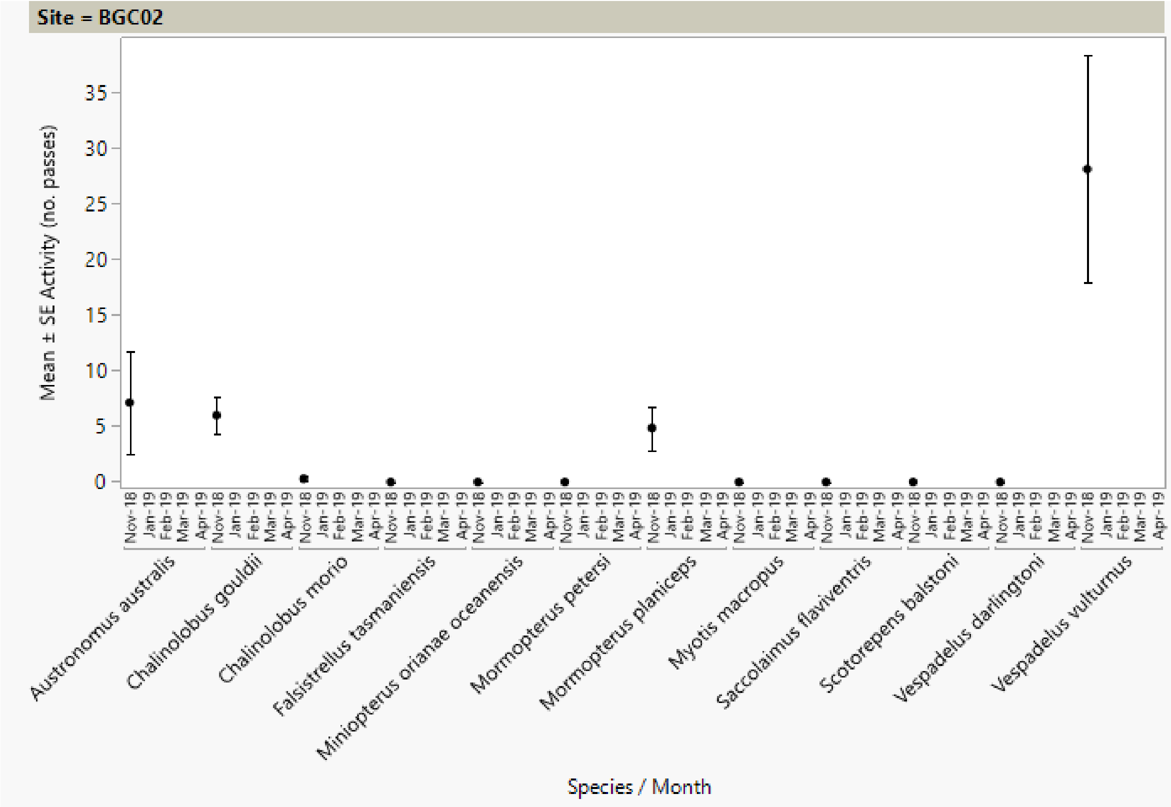
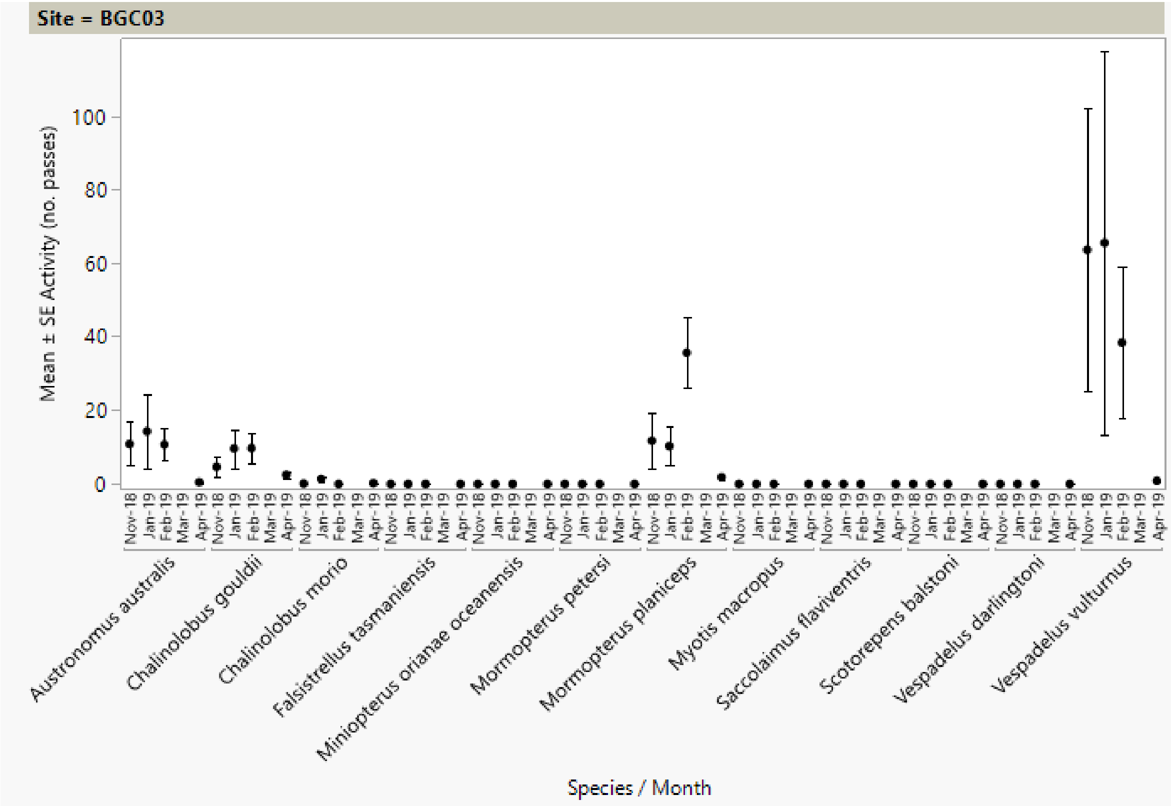


Figure A4: Riparian 2m Nightly Moo/Vespadelus activity during the Autumn migration period (including immediately before and after) by site and including riparian sites only.

All Species Activity




Site = BGC02
Mean ± SE Activity (no. passes)
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus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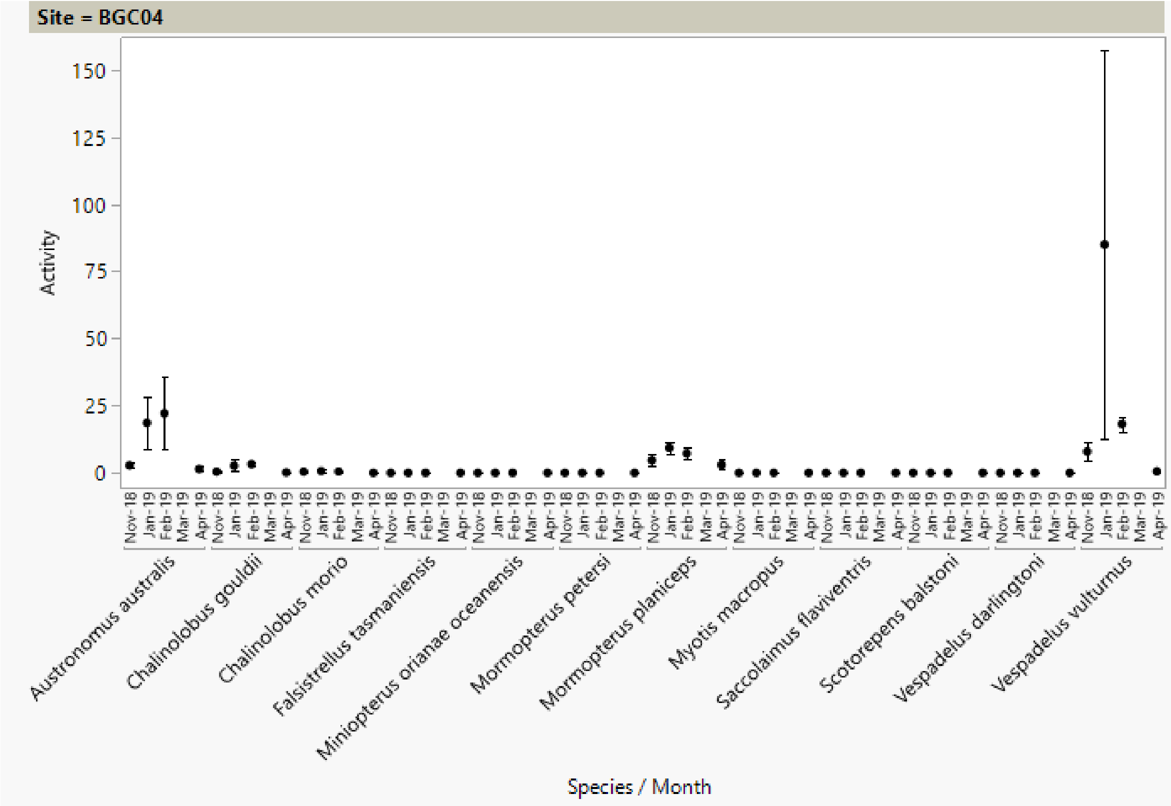
Mean ± SE Activity (no. passes)
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus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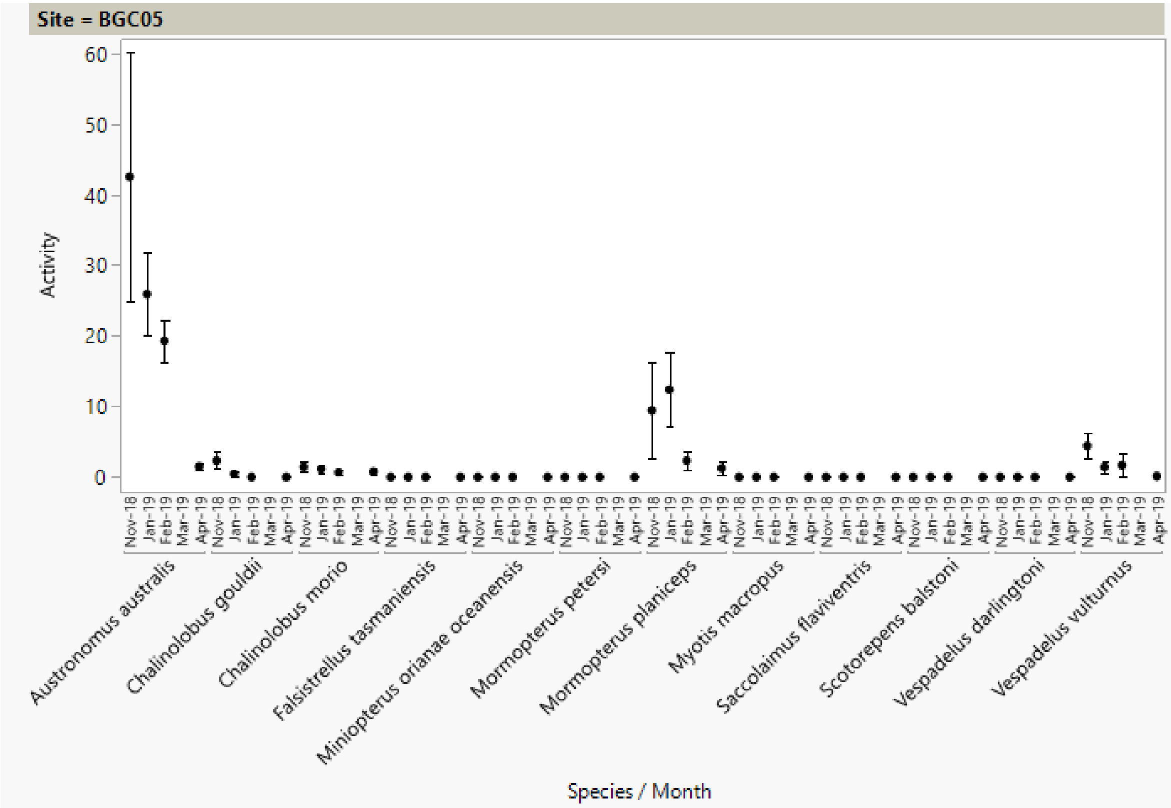
Activity
150
125
100
75
50
25
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month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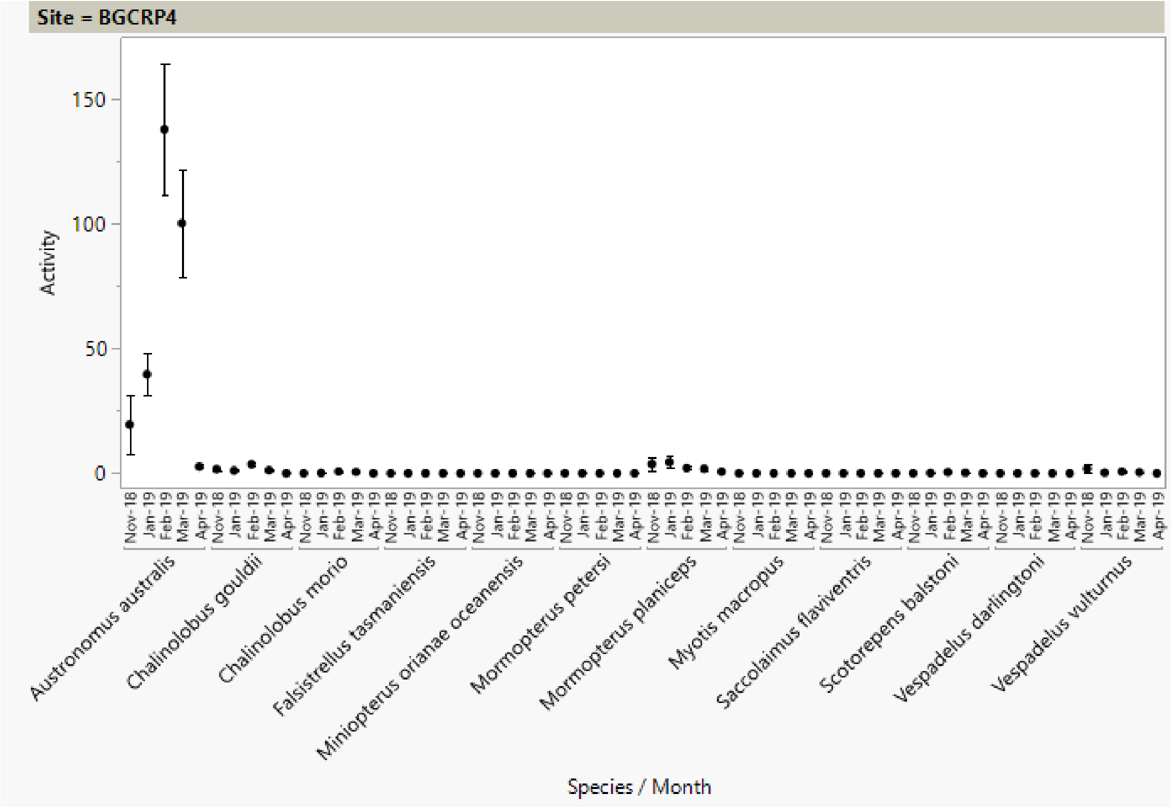
Activity
60
50
40
30
20
10
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month


Site = BGCRP4
Activity
150
100
50
0
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
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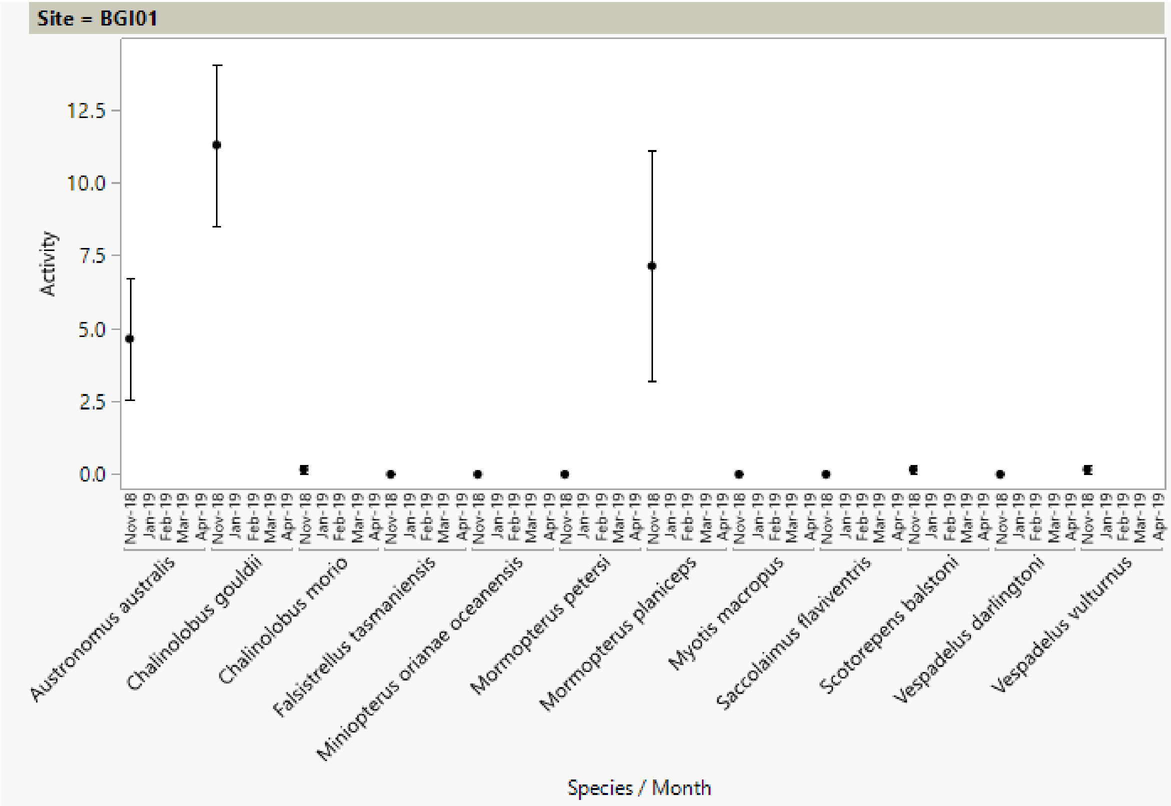
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19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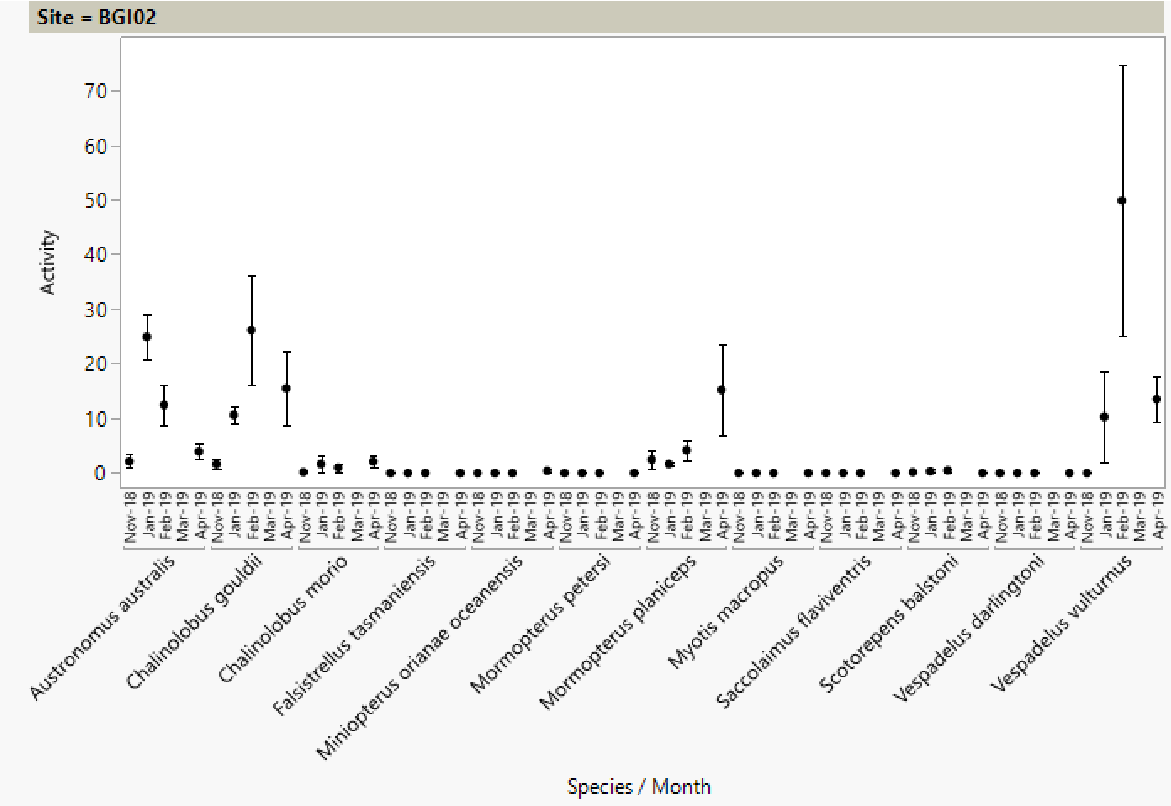
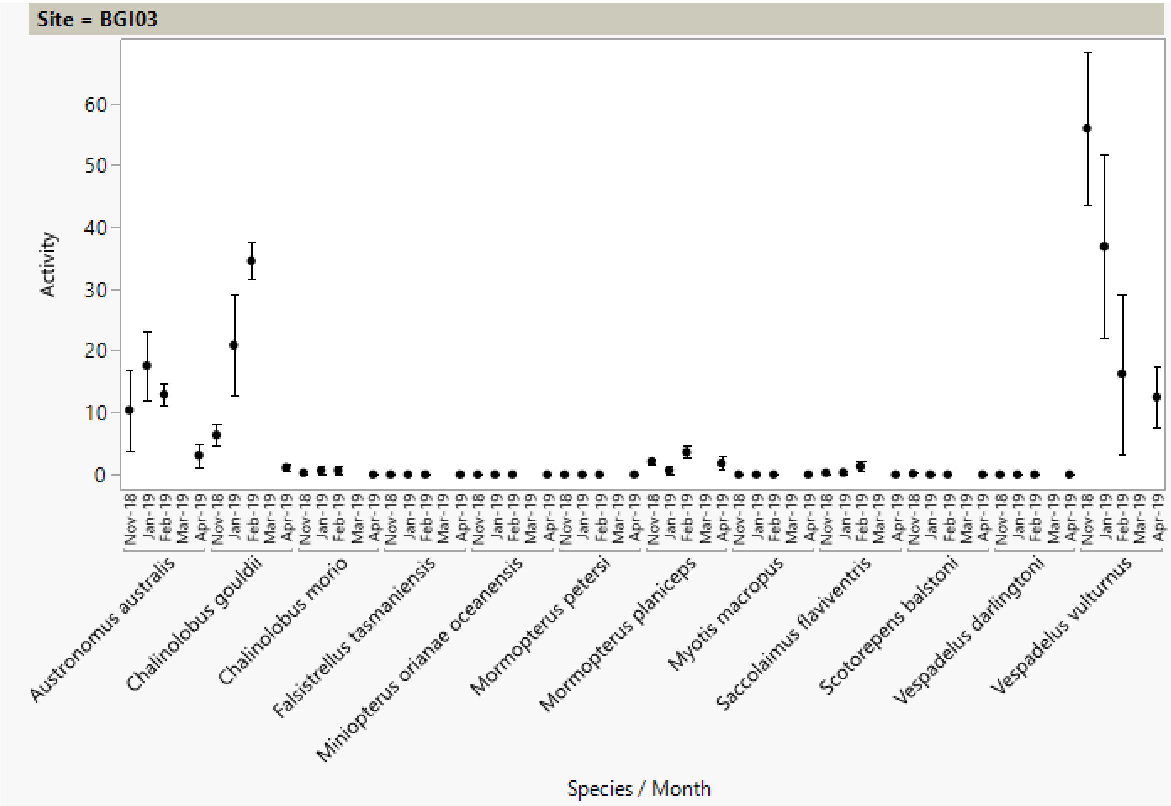
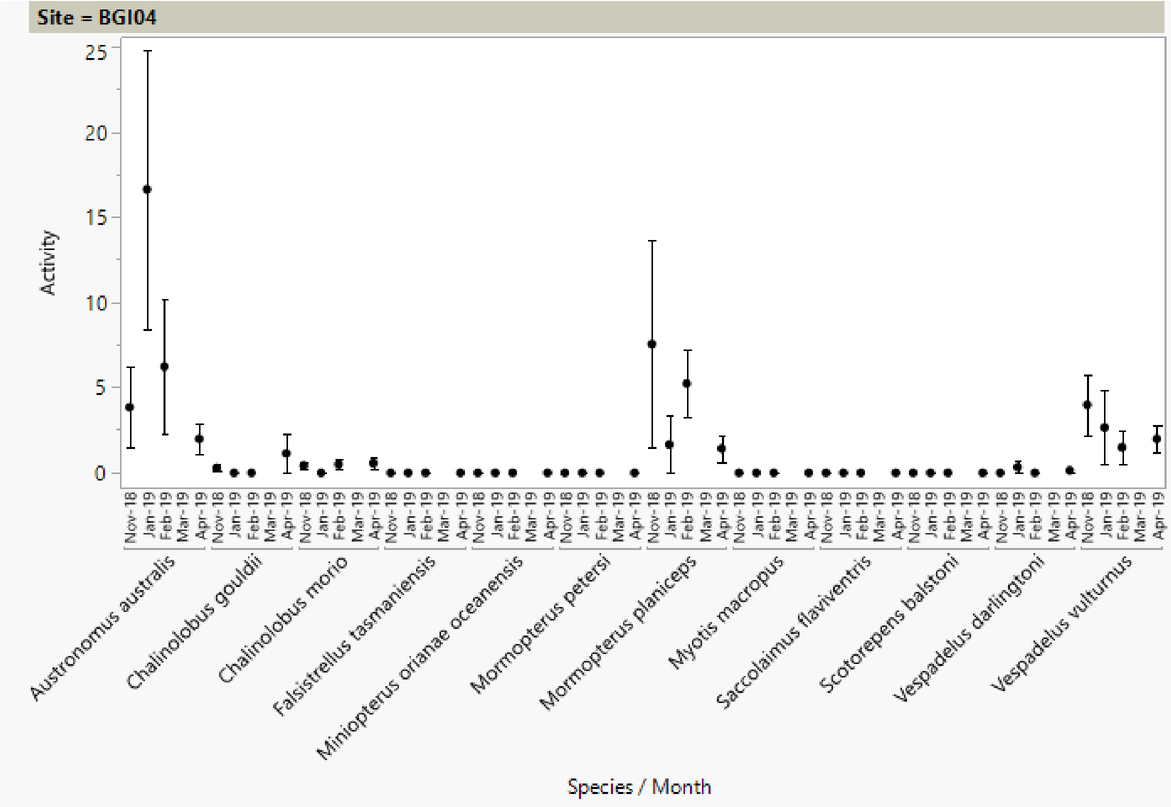
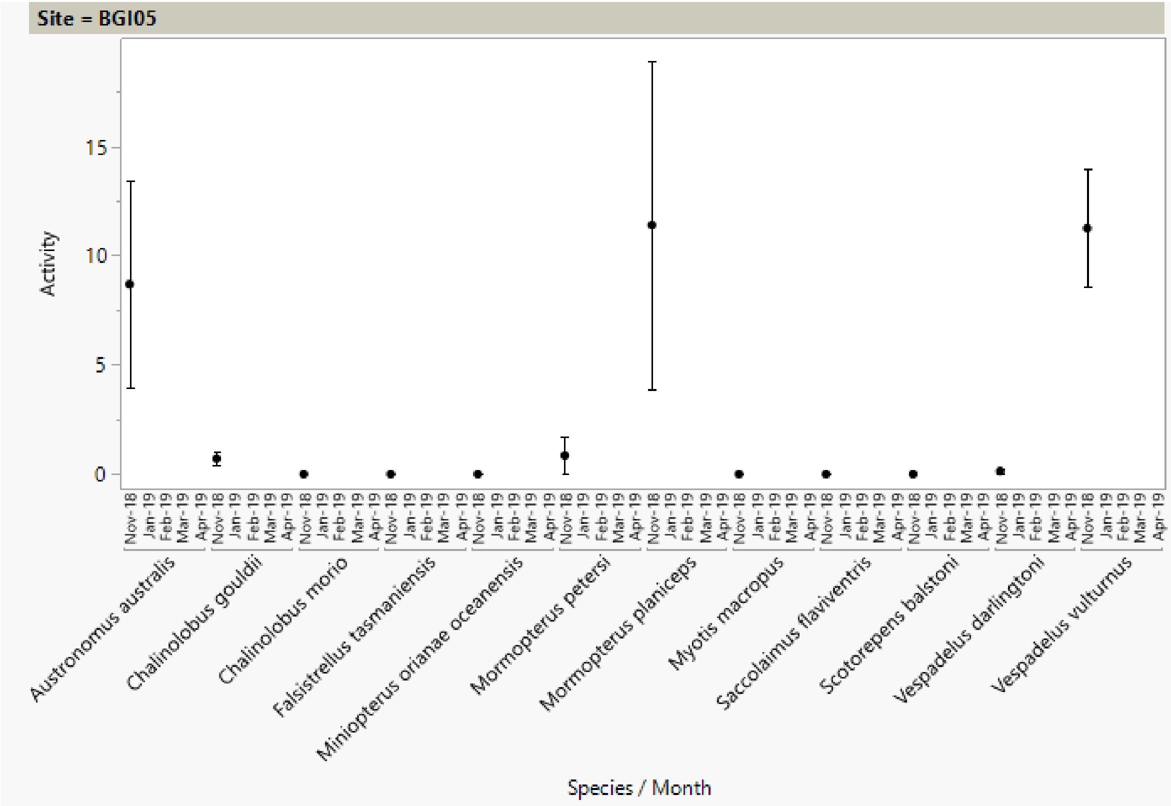
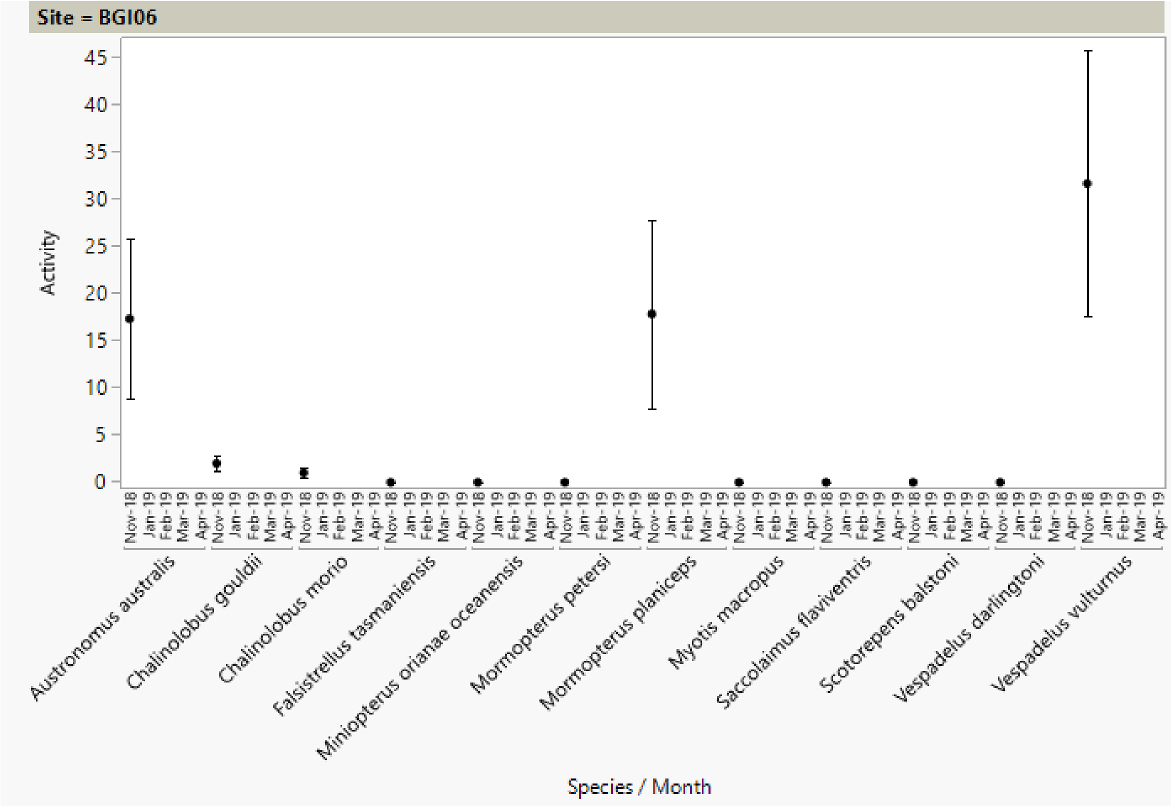
Activity
12.5
10.0
7.5
5.0
2.5
0.0
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19

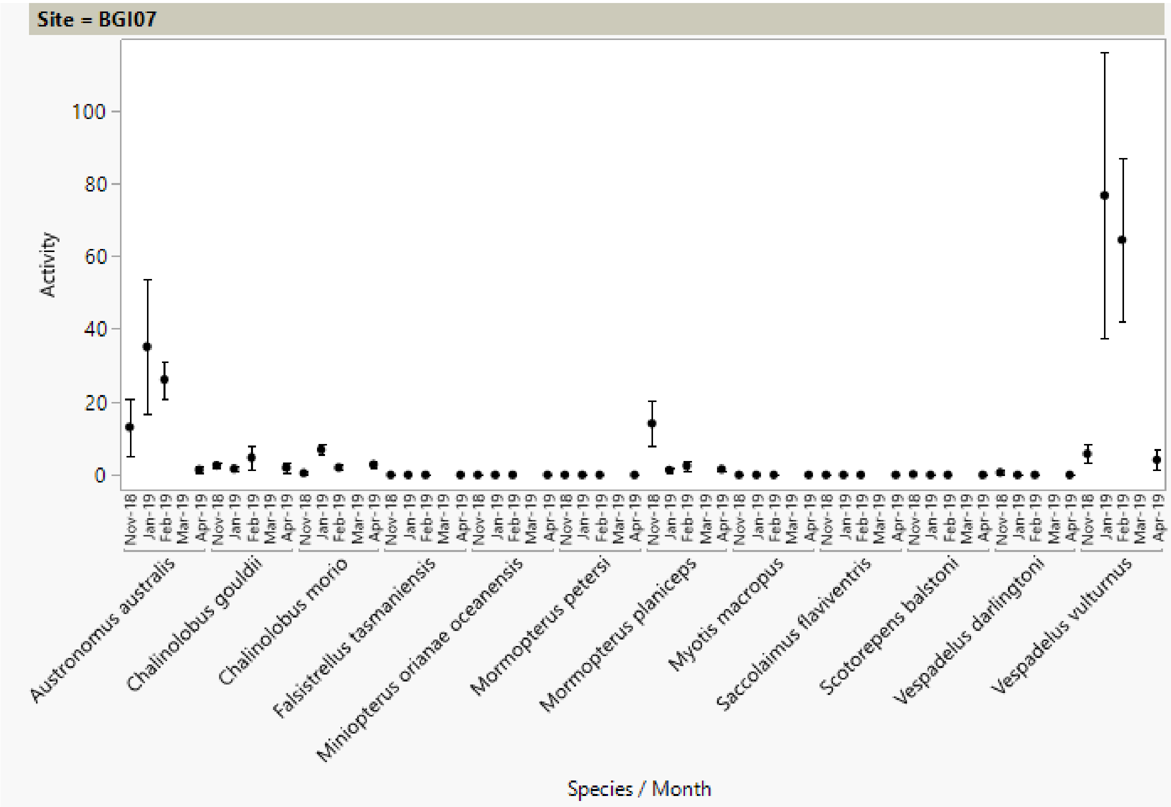

Site = BGI02
Activity
0
10
20
30
40
50
60
70
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

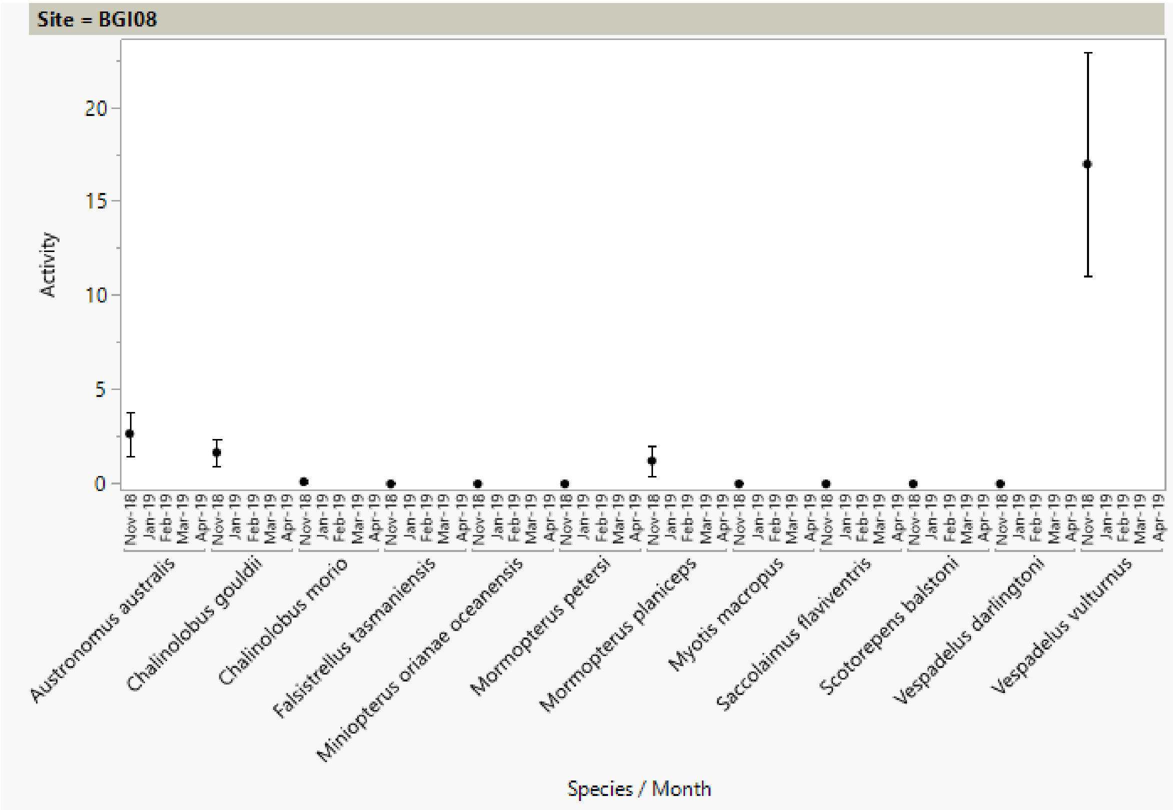

Site = BGI03
Activity
0
10
20
30
40
50
60
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

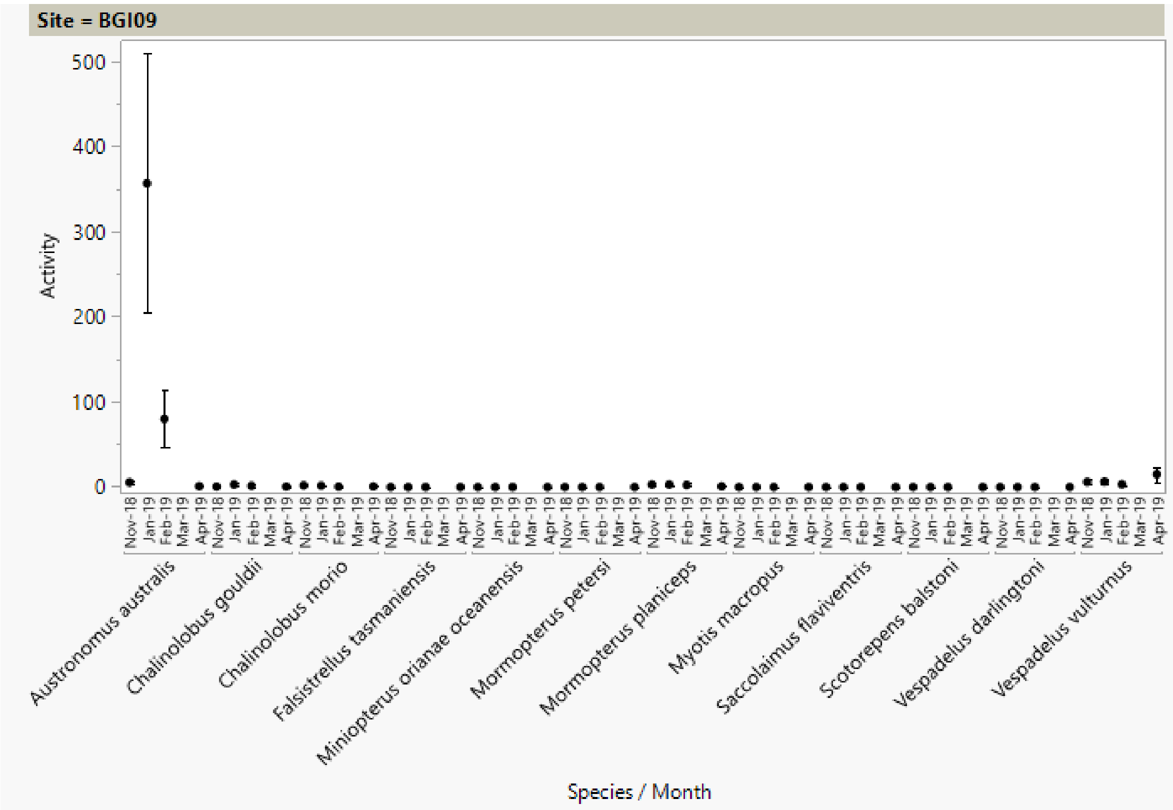

Site = BGI04
Activity
25
20
15
10
5
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

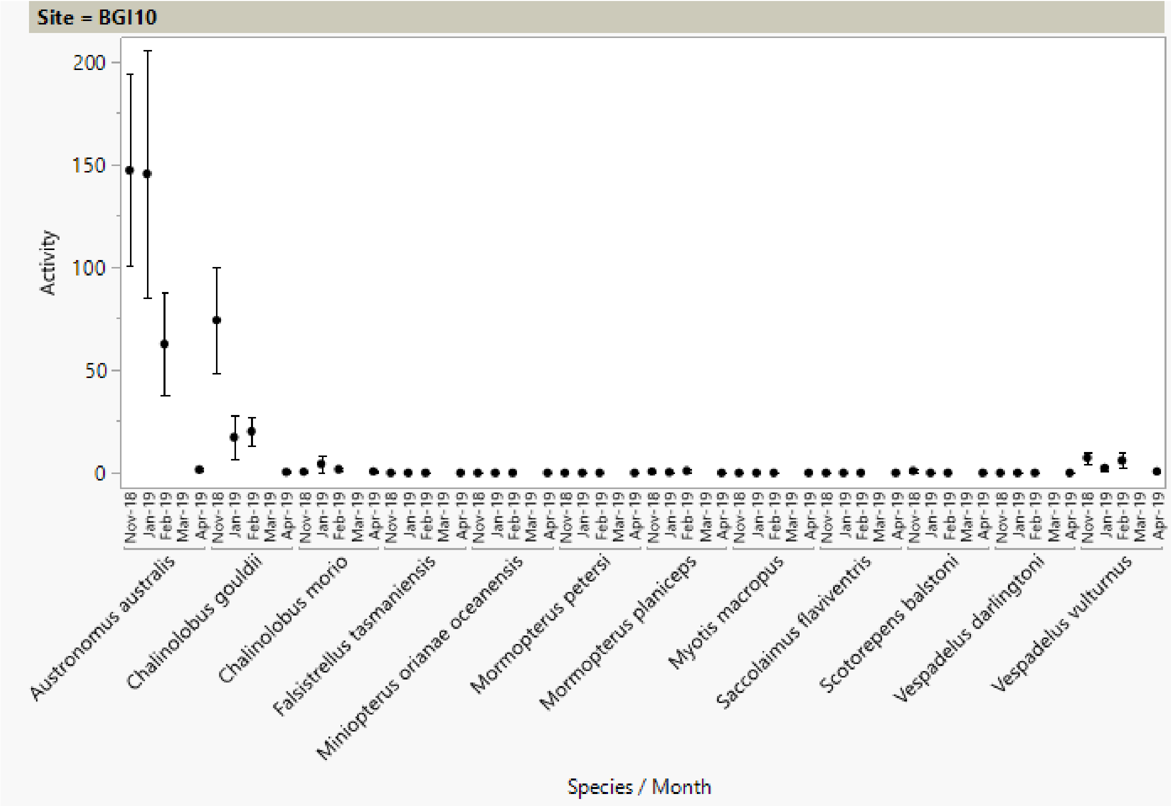

Site = BGI05
Activity
15
10
5
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

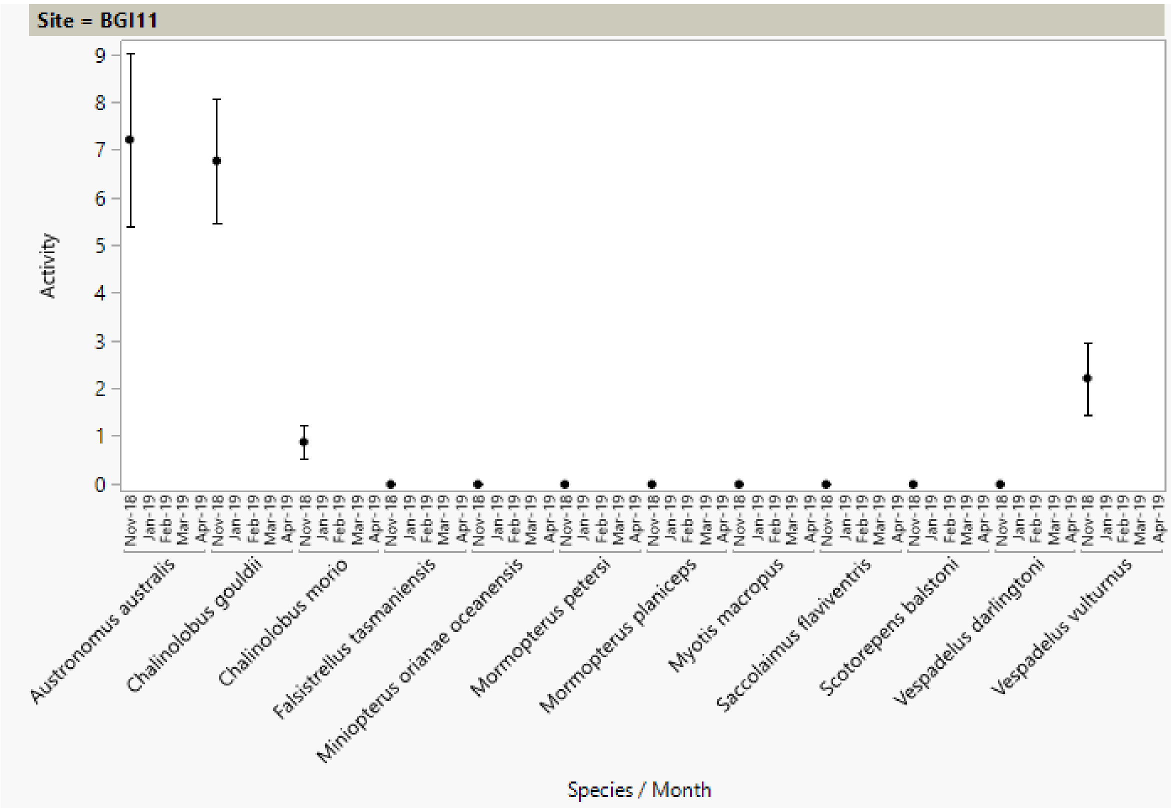

Site = BGI06
Activity
45
40
35
30
25
20
15
10
5
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

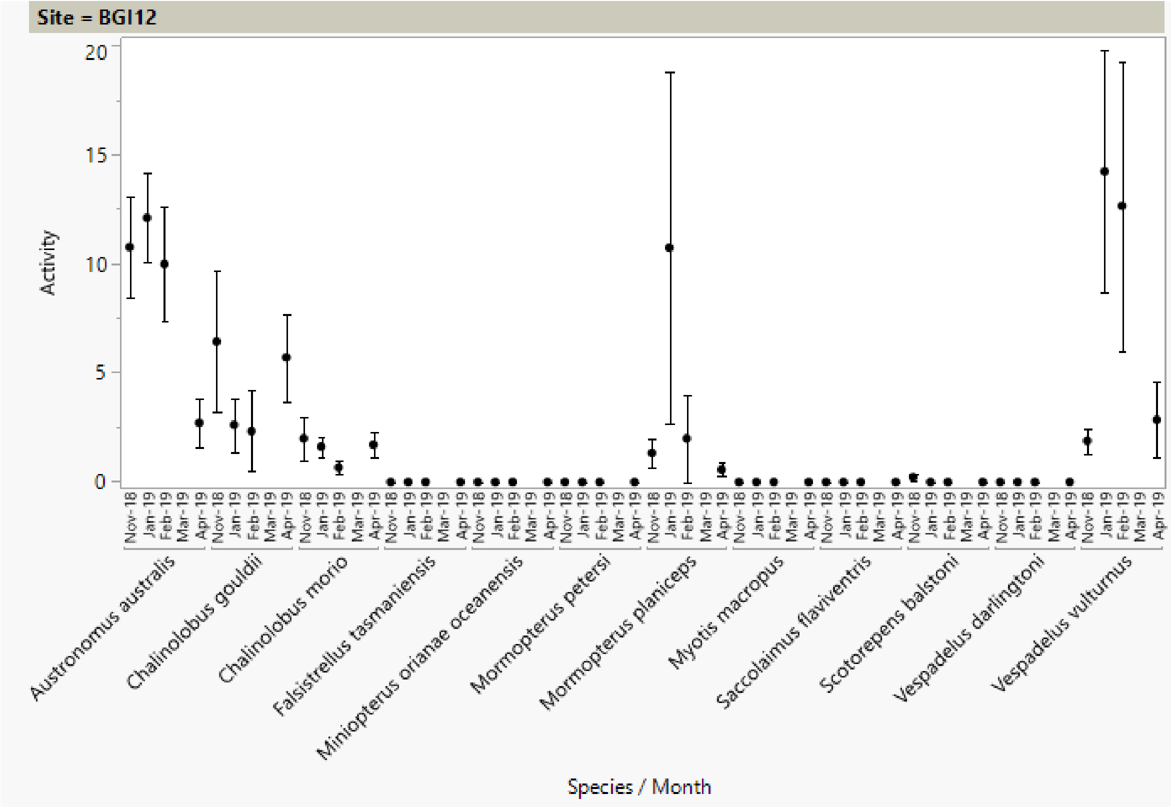

Site = BGI07
Activity
100
80
60
40
20
0
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

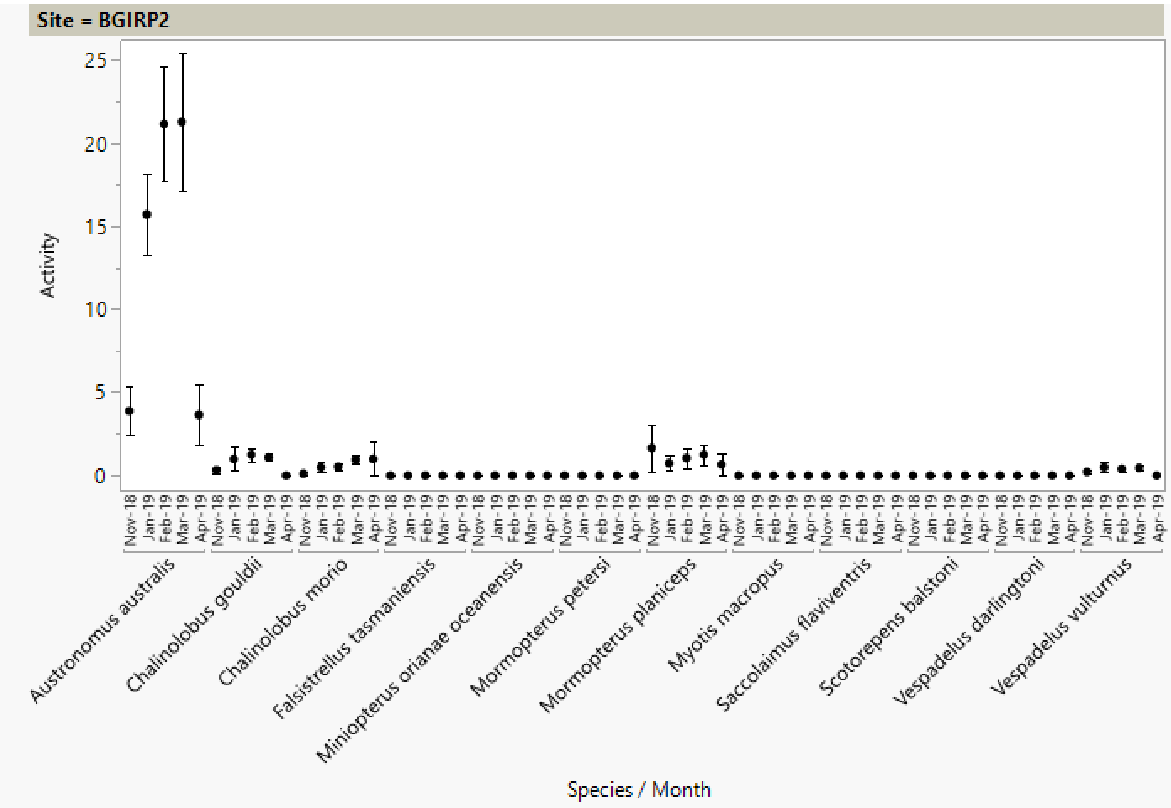

Site = BGI08
Activity
0
5
10
15
20
Nov-18 Jan-19 Feb-19 Mar-19 Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

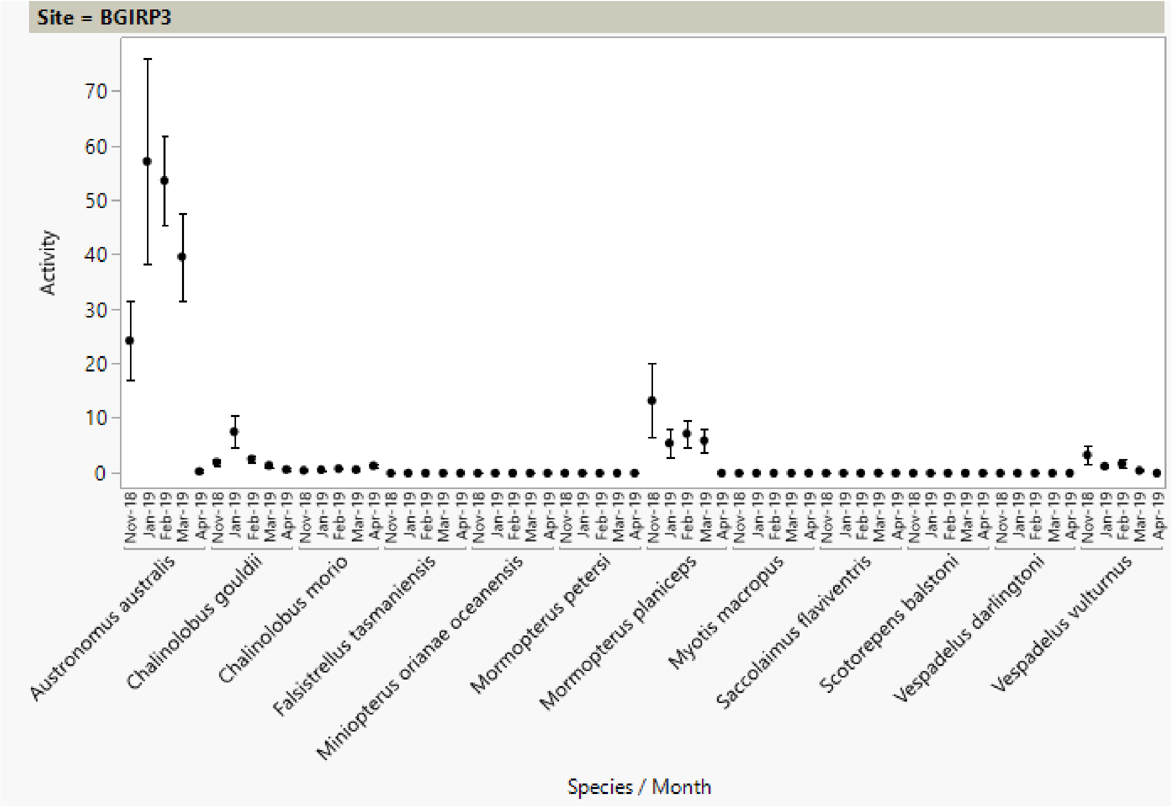

Site = BGI09
Activity
0
100
200
300
400
500
Nov-18 Jan-19 Feb-19 Mar-19 Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

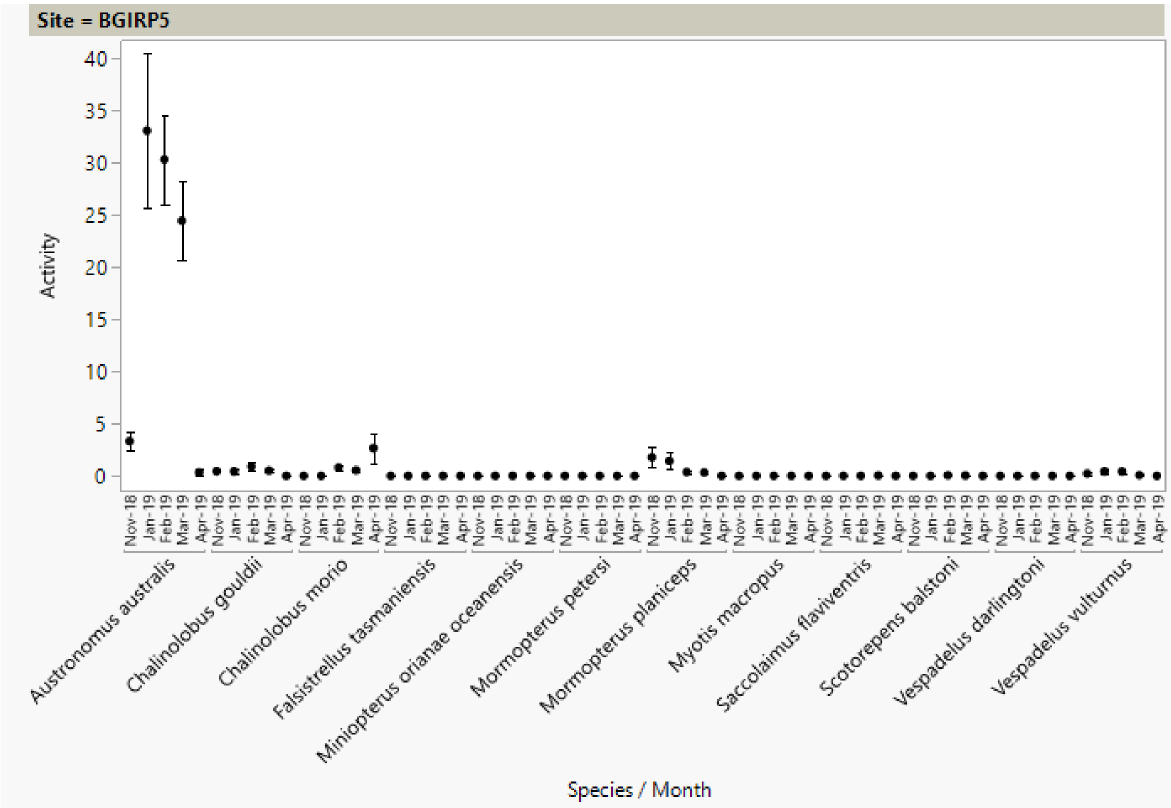

Site = BGI10
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus

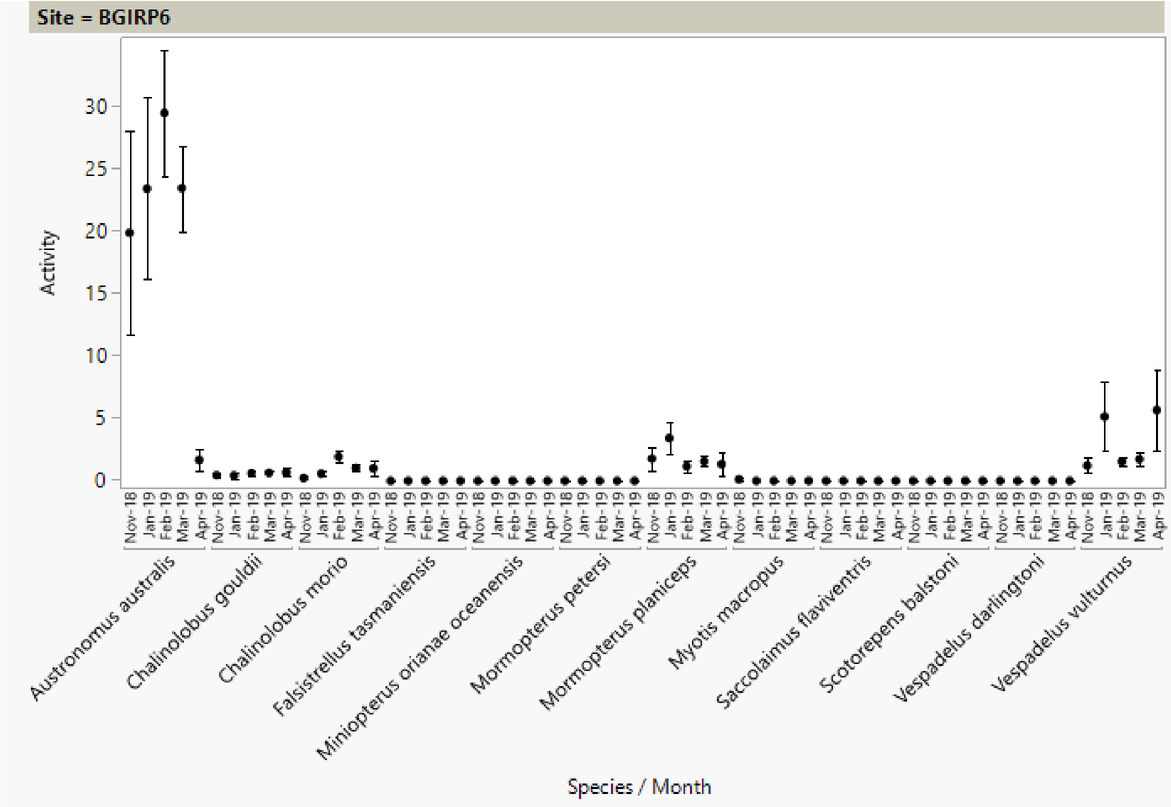

Site = BGI11
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus

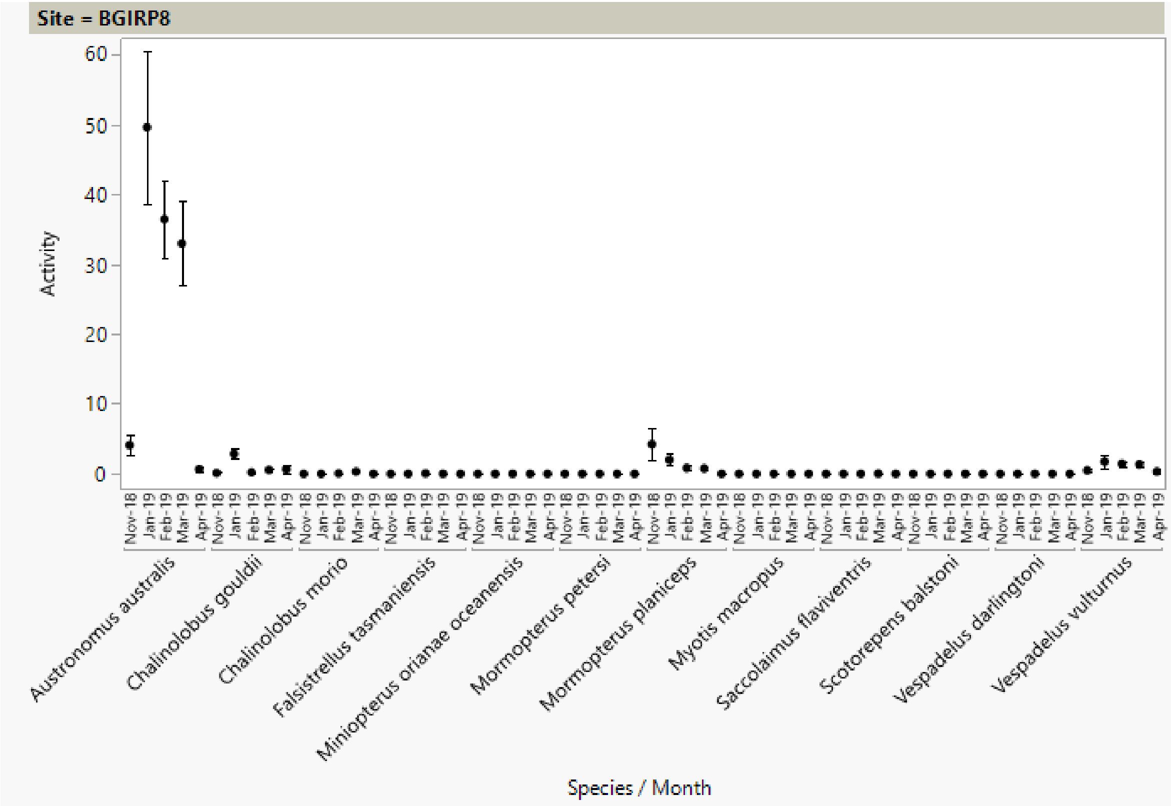

Site = BGI12
Activity
0
5
10
15
20
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Species / Month

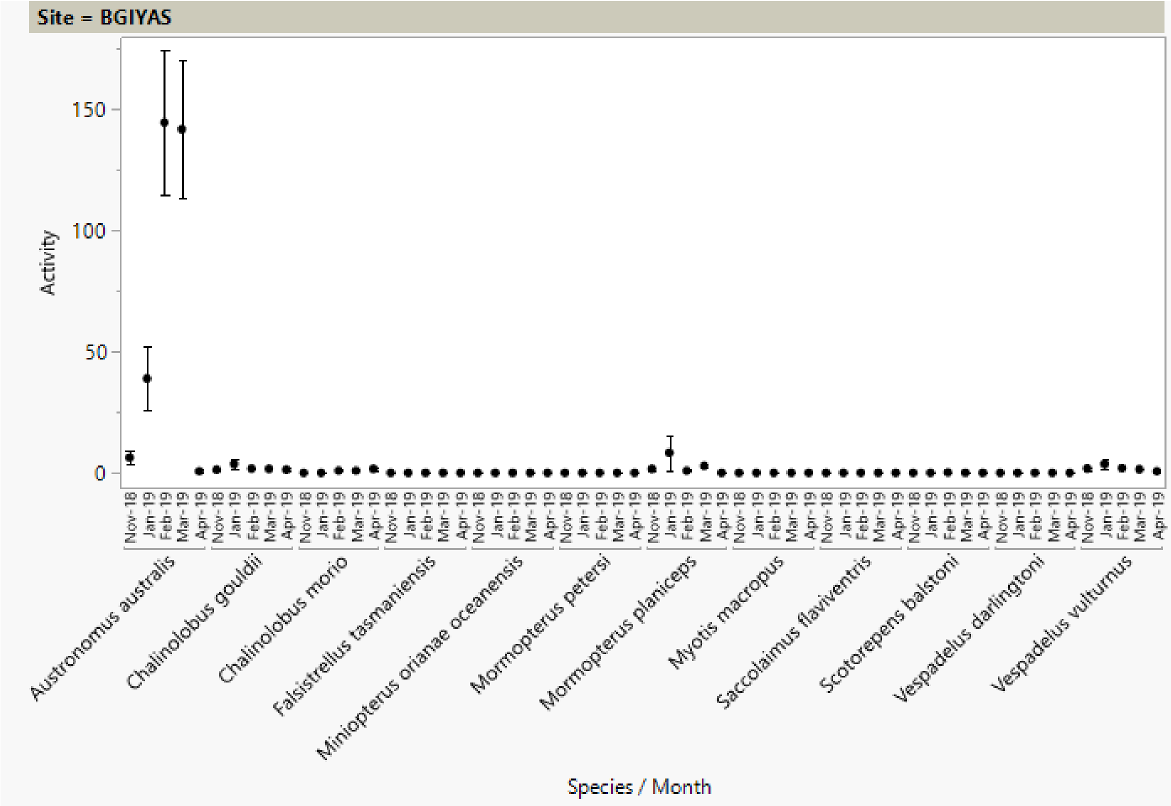

Site = BGIRP2
Activity
0
5
10
15
20
25
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Species / Month

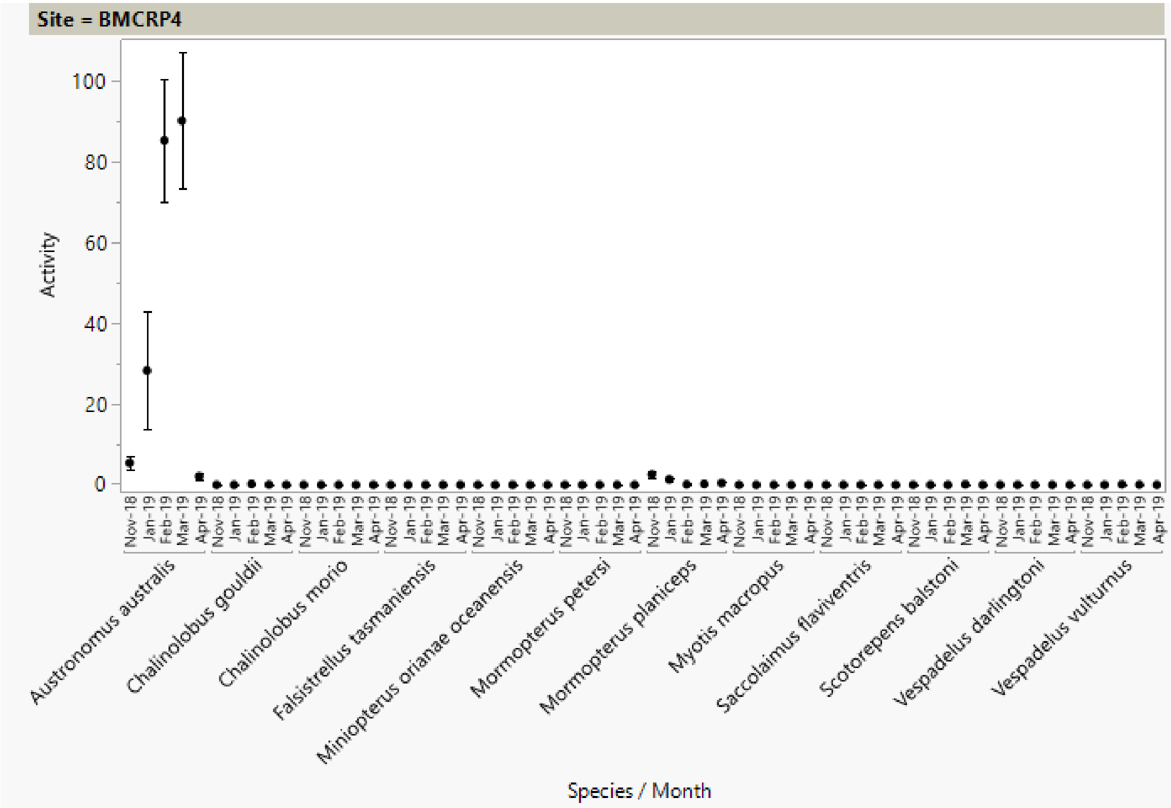

Site = BGIRP3
Activity
0
10
20
30
40
50
60
70
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month


Site = BGIRP5
Activity
0
5
10
15
20
25
30
35
40
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month


Site = BGIRP6
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus


Site = BGIRP8
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus


Site = BGIYAS
Activity
150
100
50
0
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Species / Month


Site = BMCRP4
Activity
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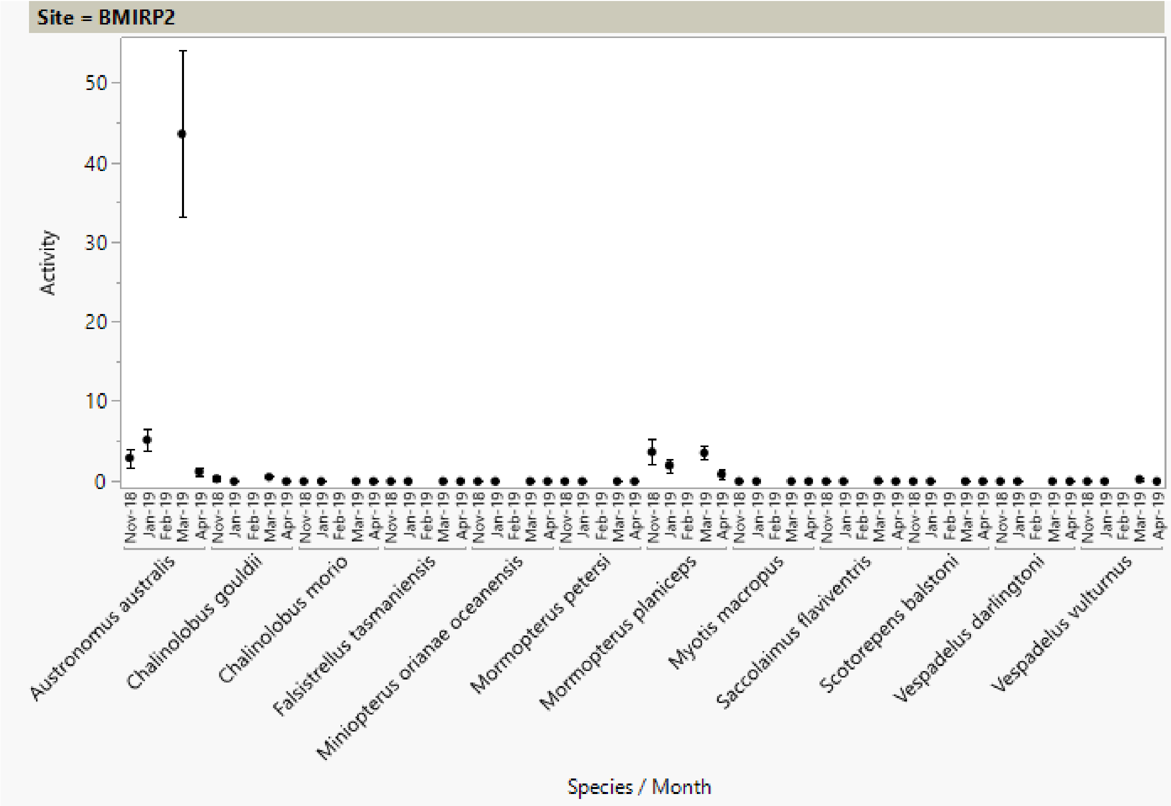
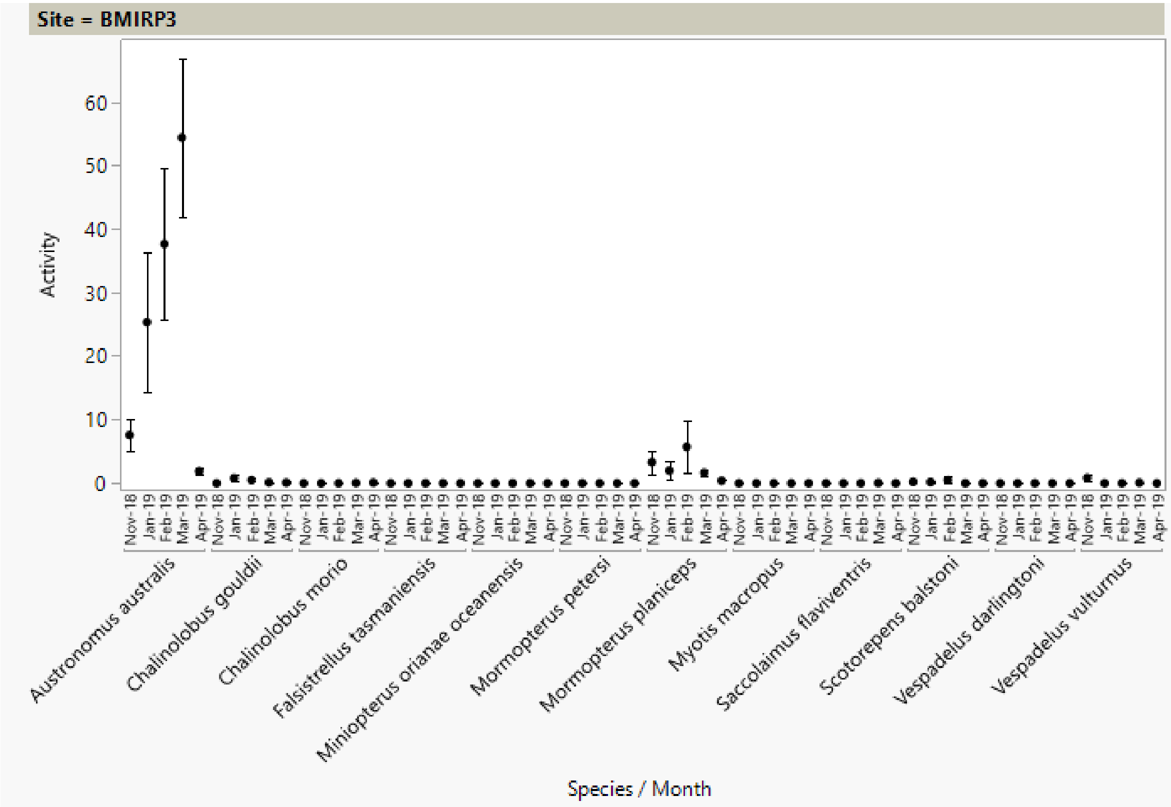
80
60
40
20
0
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Species / Month


Site = BMIRP2
Activity
0
10
20
30
40
50
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month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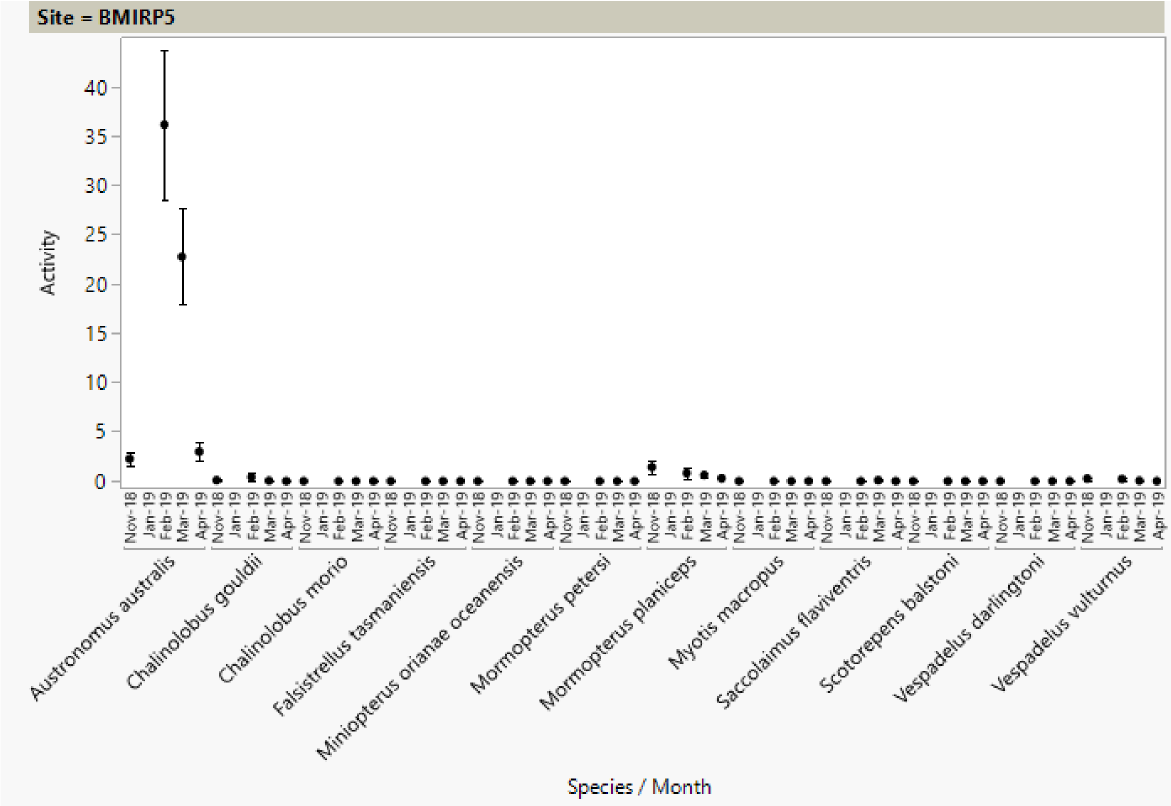
Activity
0
10
20
30
40
50
60
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month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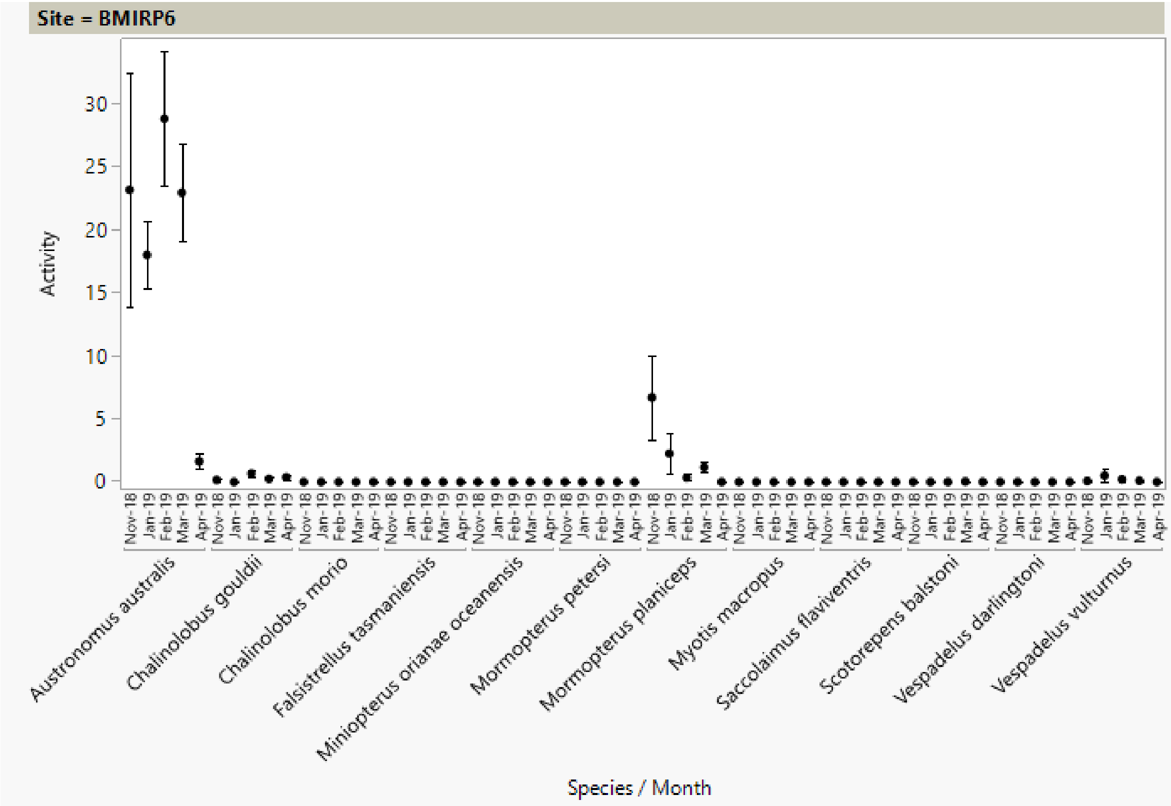
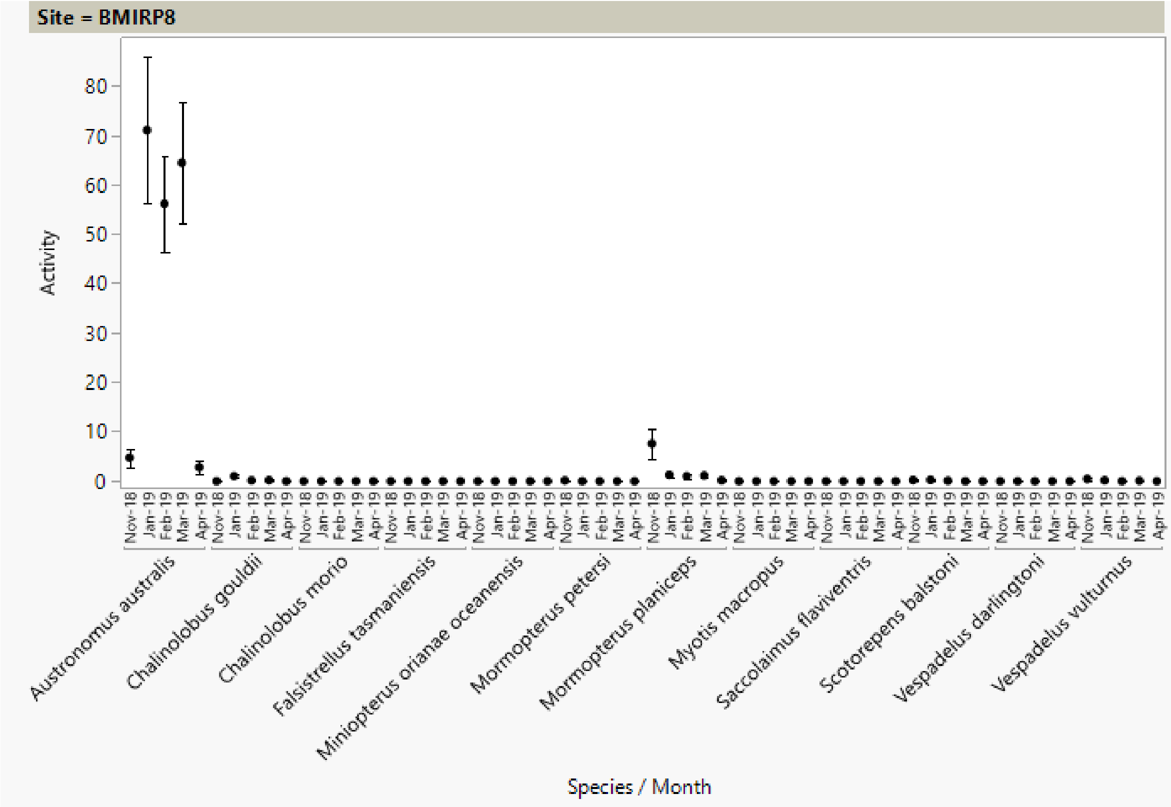
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19


Site = BMIRP6
Activity
Species / Month
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19


Site = BMIRP8
Activity
0
10
20
30
40
50
60
70
80
Nov-18
Jan-19
Feb-19
Mar-19
Apr-19
Austronomus australis
Chalinolobus gouldii
Chalinolobus morio
Falsistrellus tasmaniensis
Miniopterus orianae oceanensis
Mormopterus petersi
Mormopterus planiceps
Myotis macropus
Saccolaimus flaviventris
Scotorepens balstoni
Vespadelus darlingtoni
Vespadelus vulturnus
Species / Month

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